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Alternatives Evaluation Technical Reference Document

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Environmental Impact Statement

Draft

Mammoth Cave Area, Kentucky

Alternatives Evaluation Technical Reference Document

Vol. III

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This Draft EIS addresses proposed wastewater facilities for the Mammoth Cave Area cities of Horse Cave, Cave City, Park City and Munfordville, Kentucky and the Mammoth Cave National Park. Eight wastewater management alternatives have been evaluated with particular attention to the sensitivity of the cave environment to wastewater discharges, the resource value and importance of the caves, the complexity of the area's subsurface hydrology and the financial impacts of the alternatives on the communities.

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Munfordville, KY
201 wastewater facilities

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MAMMOTH CAVE AREA, KENTUCKY
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT ALTERNATIVES EVALUATION TECHNICAL REFERENCE DOCUMENT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

ATLANTA, GEORGIA 30365

ENVIRONMENTAL IMPACT STATEMENT
ALTERNATIVES EVALUATION TECHNICAL REFERENCE DOCUMENT
MAMMOTH CAVE AREA, KENTUCKY
201 FACILITIES PLAN

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PART A. INTRODUCTION

1. INTRODUCTION

As previously discussed in the Alternatives Development Technical Reference Document, wastewater treatment and disposal in the study area is presently handled locally by each population center. However, potential economic and/or environmental damages may encourage combining wastewaters from two or more population centers for joint treatment and/or disposal. There are two service methods of providing wastewater treatment and disposal that are to be evaluated, local treatment and disposal, and joint treatment and/or disposal. Those combinations of population centers in the study area that appear to be suited for some type of joint treatment/disposal are presented in Table II-4, of the Alternatives Development Technical Reference Document.

The eight wastewater service configurations developed in the Alternatives Development Technical Reference Document, Figures II-1 to II-8, provide eight distinct approaches to providing wastewater treatment/disposal service using varying combinations of local and joint treatment/disposal. They range from joint treatment/disposal by all population centers except Munfordville (Alternative Nos. 1 and 2) to local treatment and disposal of wastewater at each population center (Alternative No. 8). These service configurations do not specify levels or types of treatment nor do they indicate disposal practices to be used, but rather present alternative methods of providing wastewater treatment and disposal service in the study area. For example, service configuration No. 8 calls for local wastewater treatment and disposal by each of the five population centers, but a recommended method of treating and disposing the wastewaters at each location is not included.

The eight service configurations serve as the basis for the eight wastewater management alternatives to be evaluated in this report. A wastewater management alternative is developed by proposing specific wastewater conveyance, treatment and disposal methods and facilities for a particular service configuration. It is evident, however, that there exists the possibility of large numbers of wastewater management alternatives being developed from any one service configuration since there may be several wastewater treatment and disposal options available to each population center or joint treatment/disposal population center combination in the service configuration. For example, if there are two possible methods of providing local wastewater treatment and disposal at each of the five population centers, service configuration No. 8 could spawn a possible thirty-two wastewater management alternatives. In order to reduce the number of wastewater management alternatives to be evaluated to the number of service configurations, an evaluation process must first be conducted to select recommended wastewater treatment/disposal methods and facilities for each joint treatment/disposal combination as well as for each population center. By incorporating these recommendations into the appropriate service configuration(s), the eight wastewater management alternatives to be evaluated are formed.

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In this report, therefore, there are two evaluation steps to be considered. The first involves the evaluation and selection of recommended wastewater treatment disposal options for each local and joint treatment combination. The second is the cost-effectiveness evaluation of the eight wastewater management alternatives.* It is important to understand that the selection of a recommended local or joint treatment/disposal option is, in fact, only a recommendation for the purposes of developing the wastewater management alternatives. Although each recommendation is considered to represent the most favorable solution for local treatment for the particular population center or joint treatment/disposal for the particular population center combination, it is not considered final and may be altered pending additional information. The evaluation of the eight wastewater management alternatives does not include the selection of a preferred alternative. A ranking of the eight wastewater management alternatives according to each of the cost-effectiveness criteria is presented. The selection of a preferred alternative will not be completed until after public participation is completed on this phase of the EIS.

PART B. EVALUATION AND SELECTION OF WASTEWATER COLLECTION, CONVEYANCE, AND TREATMENT TECHNIQUES

1. INTRODUCTION

General descriptions of local wastewater treatment and disposal options to be evaluated are presented in Table II-7 in the Alternatives Development Technical Reference Document. Likewise, Table II-8 contains general descriptions of joint wastewater treatment/disposal options for each population center combination in the service configurations. However, since these are only general descriptions, no specific collection, conveyance, treatment or disposal facilities are specified. Treatment levels, and disposal methods and locations are given, but only in general terms such as "secondary treatment" or "spray irrigation". No cost evaluation of these options can be performed until specific methods and facilities are considered. This requires some preliminary evaluation of types of collection, conveyance, treatment and disposal systems to be incorporated into these treatment/disposal options.

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* Parts B and C of this report include original 1979 cost evaluation figures. Costs are not updated to January 1981 since these cost evaluations are used to select local and joint treatment options to be included in the eight wastewater management alternatives and cost updating will not affect the selection.

2. COLLECTION SYSTEMS

Construction of new wastewater collection facilities to serve Park City and the expansion of the Munfordville wastewater collection system to serve the remainder of that municipality are the only collection systems considered in any local or joint treatment/disposal option. Although the 201 Plan provides for some expansion of the Cave City and Horse Cave systems, these expansions are expected to occur regardless of the option selected. The proposed collection facilities at Park City and Munfordville, however, are critical elements of the options in which they are included.

Because of the hilly terrain and shallow rock generally found in karst areas, low pressure sewers may be a favorable alternative to conventional wastewater collection systems. In Park City, however, it appears that the terrain is such that a conventional gravity collection system may be constructed to serve the main community. (Pumping would be required to extend service to the Southern States feed mill located on Rt. 31W.) This system is that presented by the 201 Plan and is displayed in Figure III-1. A comparison of cost estimates for a conventional collection system as developed in the 201 plan, and a low pressure sewer system (using grinder pumps) to serve the same area is presented in Appendix III. The net present worth for either system is estimated to be approximately $1.6 million. Because the conventional system is considered much more reliable and since local annual costs are substantially less, the conventional system presented in the 201 Plan is the recommended collection system and is used for purposes of costing and evaluating different options that include wastewater collection systems for Park City.

Another wastewater collection system considered for Park City is the small community system to serve only the more densely developed business section. This system is included as part of an on-lot option for Park City to collect and transport wastewater to a community soil absorption site south of the L&N railroad. The most appropriate choice for this collection system appears to be a low pressure STEP system. With a STEP system, wastewater is treated by individual septic tanks and then pumped into the low pressure system by sump pumps. The STEP system not only provides the needed pressure to convey the wastewater to the disposal site, but also provides for treatment of the wastewater so that it may be distributed directly into the absorption system. The proposed low pressure sewer service area is indicated in Figure III-2.

One local treatment/disposal option for Munfordville includes expansion of the Munfordville wastewater collection system to serve the entire municipality. The conventional collection system expansion proposed in the 201 facilities plan requires construction of four new pump stations because of the hilly terrain. A comparison of estimates for the proposed conventional system and a low pressure sewer system (using grinder pumps) to serve the same area is presented in Appendix III. Because of the additional expenses associated with the pump stations, the conventional system appears to be substantially more costly than the low pressure system, with a net present worth of approximately $2.5 million compared to a net present worth of approximately $2

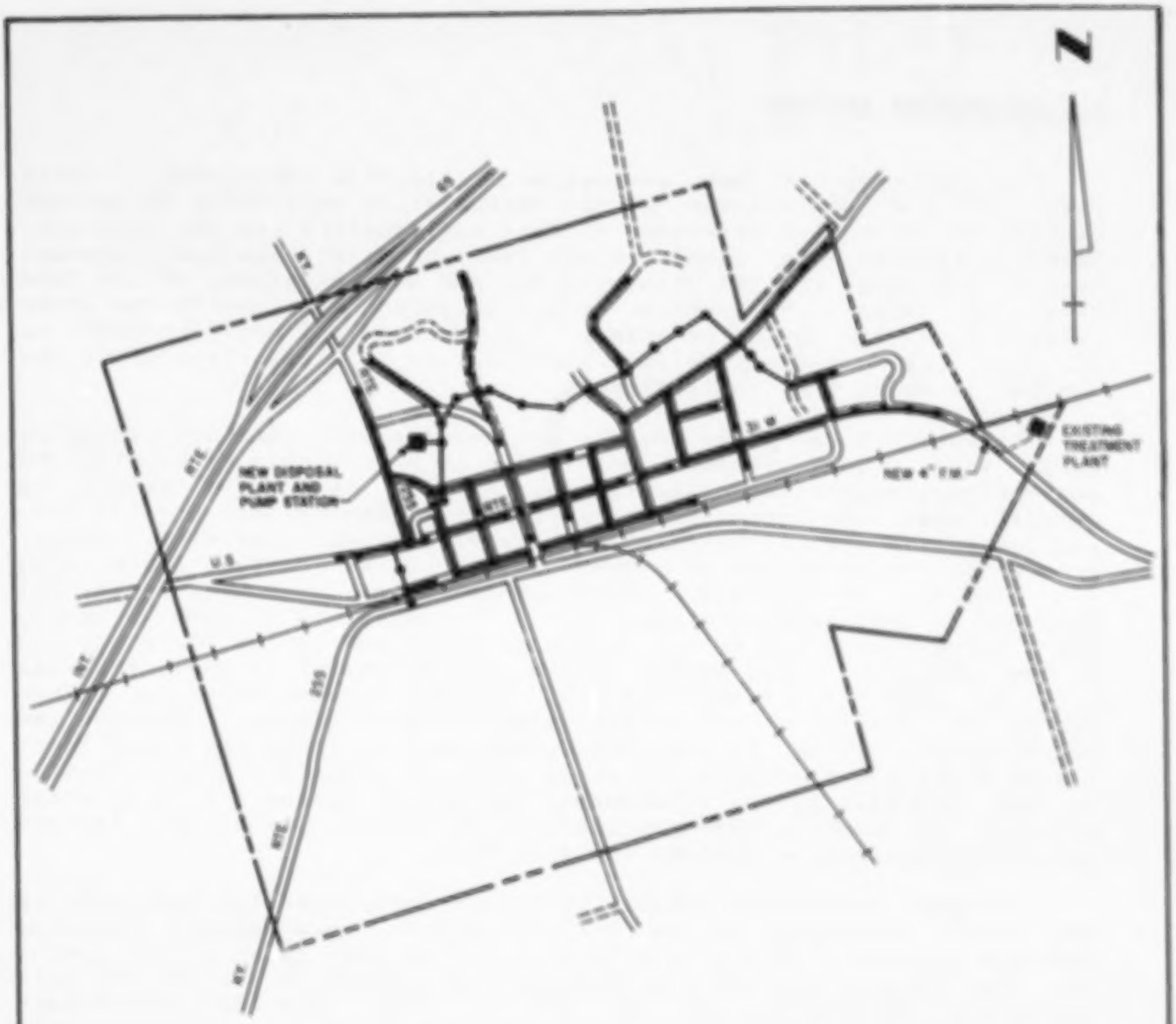
N
NEW DISPOSAL PLANT AND PUMP STATION
EXISTING TREATMENT PLANT
NEW 4" F.M.
65
KY
RTE
U.S.
31 W
INT
255
KY

FIGURE III-1

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

PROPOSED PARK CITY WASTEWATER COLLECTION SYSTEM AS PRESENTED IN THE 201 FACILITIES PLAN

1200
600
0
1200
2400
Scale In Feet

U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

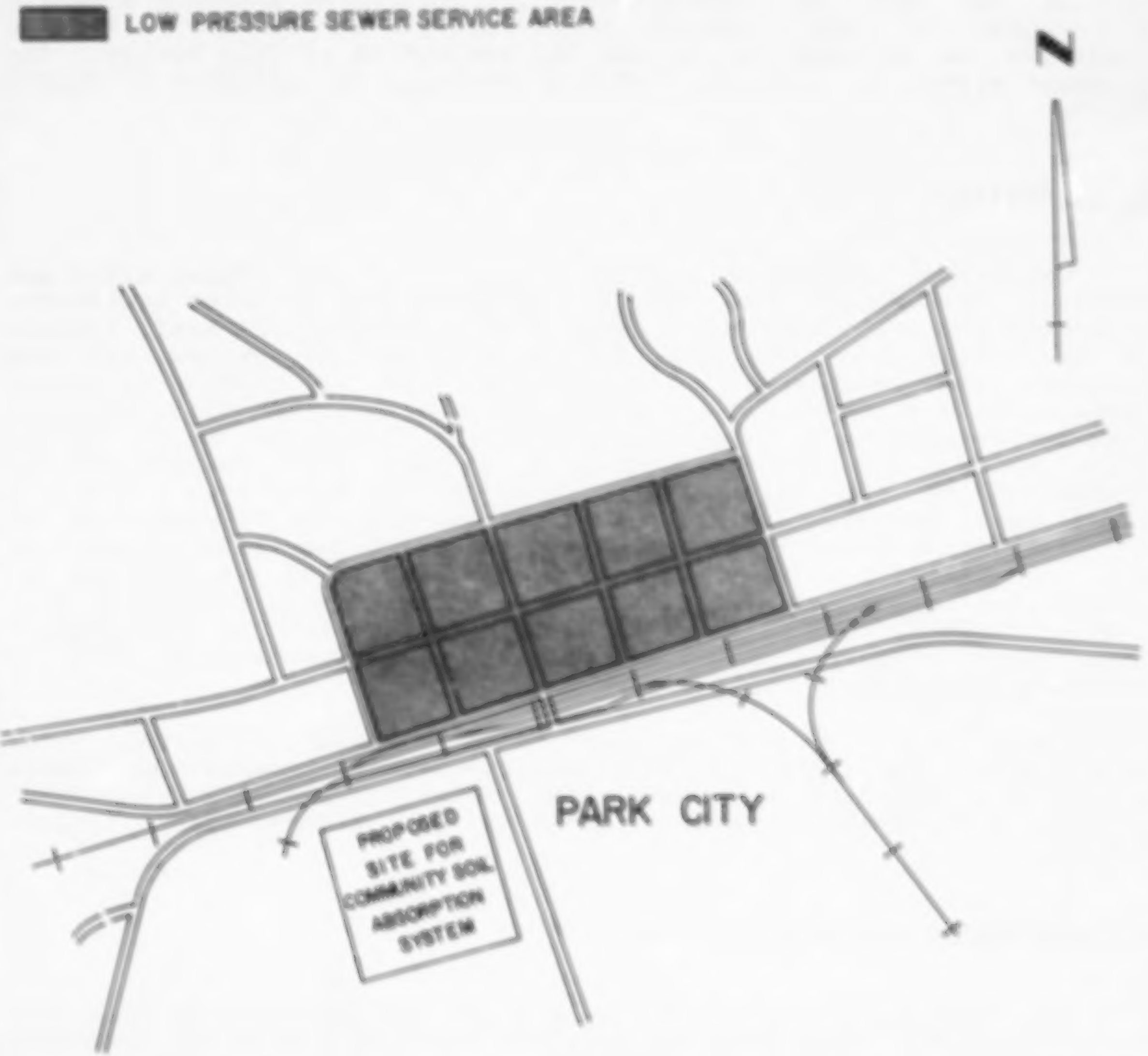
▨ LOW PRESSURE SEWER SERVICE AREA
N
PARK CITY
PROPOSED SITE FOR COMMUNITY SOIL ABSORPTION SYSTEM

FIGURE III-2

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

LOCAL OPTION PC-2
COMMUNITY LOW PRESSURE SEWER
AND SOIL ABSORPTION SITE

600 300 0 600 1200
Scale in Feet

U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

million for the low pressure system. Because of apparent economic advantages, the low pressure system is the recommended collection technique to be used for costing and evaluation of this option. The proposed wastewater collection system expansion is indicated in Figure III-3.

3. CONVEYANCE

Conveyance facilities include pump stations, force mains and gravity interceptors and are an integral part of joint wastewater treatment/disposal options. Because of the relatively small volumes of wastewater that are pumped between population centers, all pump stations are considered to be package-type for costing purposes. Force main and gravity interceptor routes between the population centers are assumed to be identical as those identified in the 201 facilities plan. For treatment dispoal options that include pumping wastewater to the Green River, however, the force main route from Horse Cave to the Green River is different than that proposed by the 201 facilities plan. Even though the length of the route proposed by the 201 facilities plan is much longer, the total dynamic head the pumps must overcome is estimated to be approximately forth-five feet less. However, the savings in pumping costs appear to be insignificant when compared with the project costs associated with the additional construction required.

Other than the alternate route recommended for the outfall force main from Horse Cave to the Green River, no alternative conveyance routes or methods are considered. The conveyance routes are indicated in the Wastewater Management Alternatives, Figure III-6 through III-13.

4. WASTEWATER TREATMENT SYSTEMS

All wastewater treatment/disposal options evaluated in this task report include provisions for specific types of biological treatment systems to provide the levels of treatment indicated in Tables II-5 and II-6 of the Alternatives Development Technical Reference Document. Selection of these specific treatment systems for incorporation into the options is based on consideration of process reliability, mechanical reliability, operational ease energy consumption, process stability design flexibility and costs. There are basically two general types of process selections that are required; process selections for new wastewater treatment facilities and process selections for upgrading existing wastewater treatment plants.

New Wastewater Treatment Facilities - Several wastewater treatment/disposal options include provisions for new wastewater treatment facilities. A summary of these new wastewater treatment facilities and the required levels of treatment is provided in Table III-1. Given the relatively small wastewater flows in the study area, extended aeration activated sludge appears to be the most appropriate wastewater treatment process for use in new wastewater facilities to

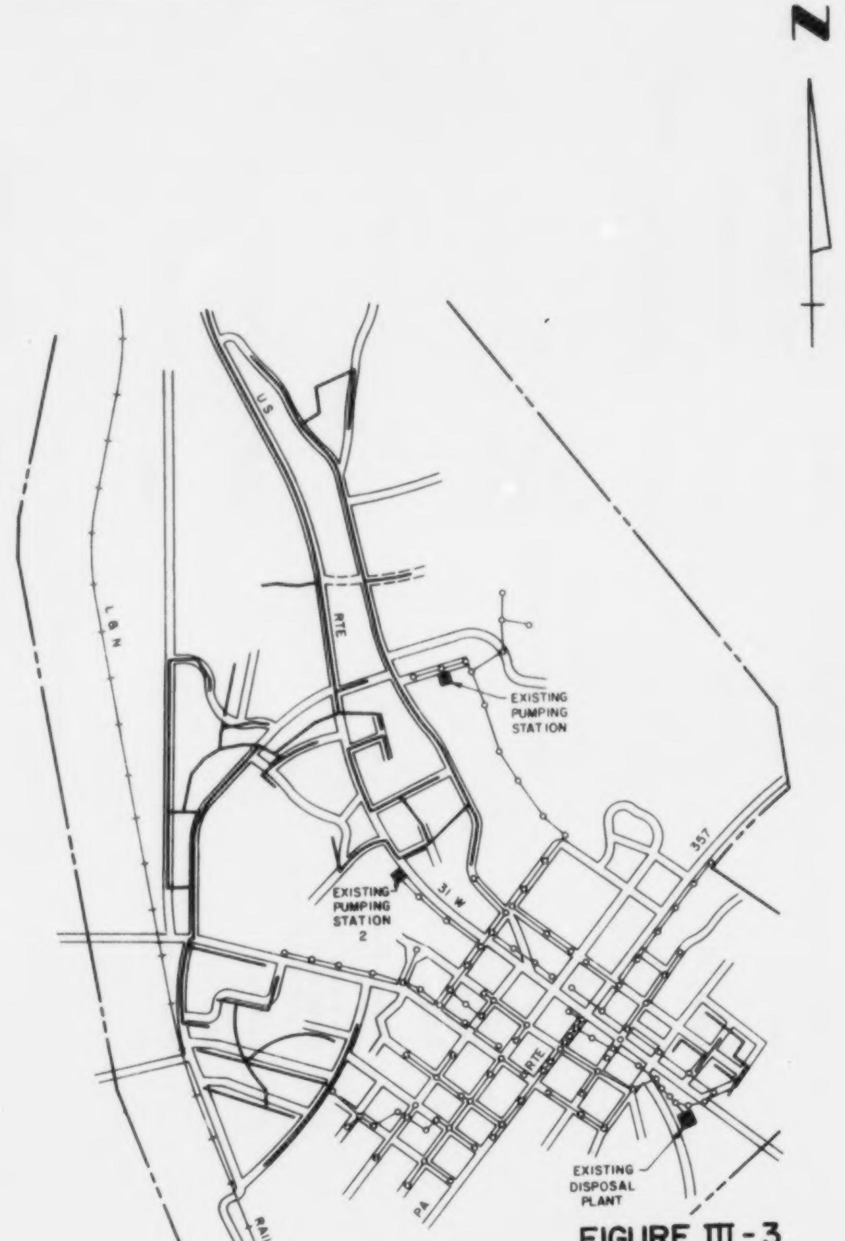
N
US RTE 31 W
L & N
RAILROAD
357
EXISTING PUMPING STATION
EXISTING PUMPING STATION 2
EXISTING DISPOSAL PLANT
PA RTE

FIGURE III - 3

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

MUNFORDVILLE LOCAL TREATMENT/ DISPOSAL OPTION MN-2 PROPOSED LOW PRESSURE SEWER SERVICE AREA

2000 1000 0 2000 4000
Scale In Feet

U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

TABLE III-1. IDENTIFICATION OF NEW WASTEWATER TREATMENT FACILITIES INCLUDED IN LOCAL AND JOINT WASTEWATER TREATMENT/DISPOSAL OPTIONS TO BE EVALUATED

Location of Proposed New Wastewater Treatment Facilities	Wastewater Source(s)	Level of Treatment Required	Design Flow (m^3/day)	Options that Include New Facilities
Park City	Park City	Secondary	0.08 mgd (303)	PC-1, (PC-SA-CC-HC)$^{1-3}$ (PC-CC-HC)$^{1-3}$, (PC-CC)$^{1-3}$
Park City	Park City Staging Area	Secondary	0.16 mgd (606)	(SA-PC-CC-HC)$^{1-3}$
Staging Area (Chaumont)	Staging Area Rt. 70 Development West of Tookey Ridge	Secondary	0.105 mgd (398)	(PC-SA-CC-HC)$^{1-3}$, (SA-CC)^{1} (SA-CC-HC)$^{1-3}$
Cave City	Cave City	Advanced Secondary	0.37 mgd (1400)	CC-1
Horse Cave	Horse Cave	Advanced Secondary	0.53 mgd (2006)	HC-3
Horse Cave	Staging Area Cave City Park City Horse Cave	Secondary	1.06 mgd (4013)	(SA-PC-CC-HC)^{3}
Horse Cave	Staging Area Cave City Park City Horse Cave Rt. 70 Development	Secondary	1.11 mgd (4202)	(SA-PC-CC-HC)^{3}
Horse Cave	Park City Cave City Horse Cave	Secondary	0.98 mgd (3710)	(PC-CC-HC)^{2}
Horse Cave	Staging Area Rt. 70 Development Cave City Horse Cave	Secondary	1.03 mgd (3899)	(SA-CC-HC)^{2}
Horse Cave	Cave City Horse Cave	Advanced Secondary	0.9 mgd (3407)	(CC-HC)^{4}
Horse Cave	Horse Cave Cave City	Secondary	0.9 mgd (3407)	(CC-HC)^{5}, (CC-HC)^{6}

serve the study area. Although operating costs may be slightly more than other biological processes because of greater energy requirements, overall units costs ($/1000 gal.), including project costs as well as operations costs, are lower than other biological treatment systems for field constructed plants less than 2 mgd,* based on amortization at 6.875 percent over the planning period. Even considering field-constructed extended aeration plants versus contact stabilization package plants in the 0.1-1 mgd range, costs for extended aeration systems are competitive based on overall unit costs.**

In addition to cost advantages for small wastewater treatment systems, the extended aeration process offers substantial operability advantages over other biological treatment processes. The plants are relatively easily operated and maintained. Also, the process is simple and predictable. Since biological solids are stabilized in the aeration process (if the plant is operated properly) no sludge digestion facilities are required, and stabilized solids may even be wasted by direct land spreading. This reduces operating complications created by solids handling requirements which are part of other biological treatment systems. Most importantly, the extended aeration process is extremely reliable and when operated properly, produce a high quality effluent that exceeds secondary treatment standards. In fact, extended aeration facilities are generally capable of providing partial or complete nitrification.

There are two types of extended aeration processes proposed for use in the Mammoth Cave area wastewater treatment/disposal options, oxidation ditch and aeration basins. Except for the package plants proposed for the Staging Area and Park City, the oxidation ditch type plant is assumed for costing and evaluation for all new treatment facilities included in the treatment/disposal options. The oxidation ditch system is capable of consistently providing advanced secondary treatment, with effluent BOD generally 10-20 mg/l.

Upgrading Existing Wastewater Treatment Facilities - The existing wastewater treatment facilities at Horse Cave and Cave City are similar processes. According to the 201 Plan each of these plants is capable of producing an effluent BOD of approximately 50 mg/l if operated at optimum efficiency. (In Horse Cave this is contingent on adequate pre-treatment of industrial wastewaters). In order to use these facilities in the future, the effluent requires upgrading to meet secondary treatment standards.

There are several wastewater treatment/disposal options evaluated that include provisions for upgrading the existing Horse Cave and Cave City treatment plants. A summary of proposed upgradings is provided in Table III-2. These include local upgrading to provide secondary treatment at each plant as well as joint upgrading by combining the effluents from both existing plants for joint secondary treatment at

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* "Small Community Wastewater Treatment Facilities - Biological Treatment System," Henry H. Benjes, Jr., Small Wastewater Treatment Facilities, U.S. EPA, January, 1978, p. 93, Figure 38.

** Ibid

TABLE III-2. IDENTIFICATION OF WASTEWATER TREATMENT PLANT UPGRADINGS INCLUDED IN LOCAL AND JOINT TREATMENT/DISPOSAL OPTIONS TO BE EVALUATED

Proposed Upgrading	Wastewater Source(s)	Level of Treatment Required	Design Capacity of Upgraded Facilities	Options that Include the Upgraded Facilities
Cave City WWTP	Cave City	Secondary	0.37 mgd (1400 m^3/day)	CC-2, (SA-PC-CC-HC)^{2} (PC-CC-HC)^{3}, (CC-HC)$^{7 \& 8}$, (PC-CC)^{1}
Cave City WWTP	Cave City Staging Area Rt. 70 Development	Secondary	0.45 mgd* (1703 m^3/day)	(SA-CC-HC)^{3}, (SA-CC)^{1}
Cave City WWTP	Cave City Staging Area Rt. 70 Development Park City	Secondary	0.53 mgd* (2006 m^3/day)	(PC-SA-CC-HC)^{2}
Cave City WWTP	Cave City	Advanced Secondary	0.37 mgd (1400 m^3/day)	CC-3, (PC-CC)^{2}
Horse Cave WWTP	Horse Cave	Secondary	0.53 (2006 m^3/day)	HC-2, HC-4, (SA-PC-CC-HC)^{2}, (PC-SA-CC-HC)^{2}, (PC-CC-HC)^{3}, (CC-HC)$^{7 \& 8}$
Horse Cave WWTP	Horse Cave	Advanced Secondary	0.53 (2006 m^3/day)	HC-1
Horse Cave & Cave City WWTP's in Joint Upgrading	Horse Cave Cave City Park City Staging Area	Secondary	1.06 mgd* (4013 m^3/day)	(SA-PC-CC-HC)^{1}
Horse Cave & Cave City WWTP's in Joint Upgrading	Horse Cave Cave City Park City Staging Area Rt. 70 Development	Secondary	1.11 mgd* (4202 m^3/day)	(PC-SA-CC-HC)^{1}
Horse Cave & Cave City WWTP's in Joint Upgrading	Park City Cave City Horse Cave	Secondary	0.98* (3710 m^3/day)	(PC-CC-HC)^{1}
Horse Cave & Cave City WWTP's in Joint Upgrading	Staging Area Rt. 70 Development Cave City Horse Cave	Secondary	1.03* (3899 m^3/day)	(SA-CC-HC)^{1}
Horse Cave & Cave City WWTP's in Joint Upgrading	Horse Cave Cave City	Secondary	0.9 (3407 m^3/day)	(CC-HC)$^{1, 2}$

*Hydraulic capacity is provided in the secondary treatment step for treated and raw wastewaters from the Staging Area, Rt. 70 development, and in some cases, Park City. The existing treatment plants at Horse Cave and Cave City are expected to be operated at optimum efficiency and continue to treat only wastewaters generated in their respective service areas. Under upgrading plans the existing Cave City facility is expected to provide treatment for 0.37 mgd; the existing Horse Cave facility 0.28 mgd since Ken Dec wastewaters are to be treated only in the secondary treatment step.

Horse Cave. Treatment requirements are secondary and advanced secondary.

Since the existing facilities are capable of providing substantial BOD_5 removal, it appears that a second stage biological treatment step in series with existing trickling filter processes is the most appropriate method of treatment for upgrading the plant effluents. Additional trickling filter facilities or other fixed film biological processes could be considered, however, based on cost and reliability considerations, activated sludge is the process of choice. Therefore, for all upgrading options, an activated sludge second stage biological treatment step is the assumed method of upgrading. For local upgrading options at either Horse Cave or Cave City this requires the addition of concrete-lime earthen aeration basins with mechanical aeration and return sludge pumping. Both plants require additional final settling facilities. General schematics of the proposed processes are provided in Figures III-4 and III-5. For joint treatment at Horse Cave, a new activated sludge facility is proposed, however, the plant would include no preliminary treatment facilities.

It is expected that a second stage activated sludge treatment step will provide secondary or advanced secondary treatment depending on the sizing of the aeration facilities. For costing purposes, secondary treatment is assumed to require four hours aeration and advanced secondary six hours aeration.

For wastewater treatment/disposal options that include conveyance from the Staging Area to Cave City and upgrading Cave City facilities to provide secondary treatment, the sizing of the activated sludge second stage treatment system includes hydraulic capacity for wastewaters from the Staging Area line. This is because raw wastewater from development along Rt.. 70 east of Toohey Ridge is to be mixed with treated wastewater from the Staging Area. It is estimated that this water will have a BOD_5 of about 50 mg/l and therefore not require preliminary treatment. Therefore, the existing Cave City facilities will provide preliminary treatment for only Cave City wastewater. Sizing of the joint upgraded treatment facilities includes hydraulic capacity for Horse Cave, Cave City and any other population centers in the option since wastewaters from all population centers are combined at Cave City prior to conveyance to Horse Cave.

PART C. SELECTION OF RECOMMENDED LOCAL AND JOINT TREATMENT/DISPOSAL OPTIONS

1. INTRODUCTION

The selection of recommended local and joint wastewater treatment/disposal options for incorporation into the eight service configurations to form eight wastewater management alternatives is the first step in the evaluation process. This is required in order to reduce the large number, if possible, of alternatives to a more man-

GENERAL PROCESS FOR UPGRADING CAVE CITY WASTEWATER TREATMENT PLANT

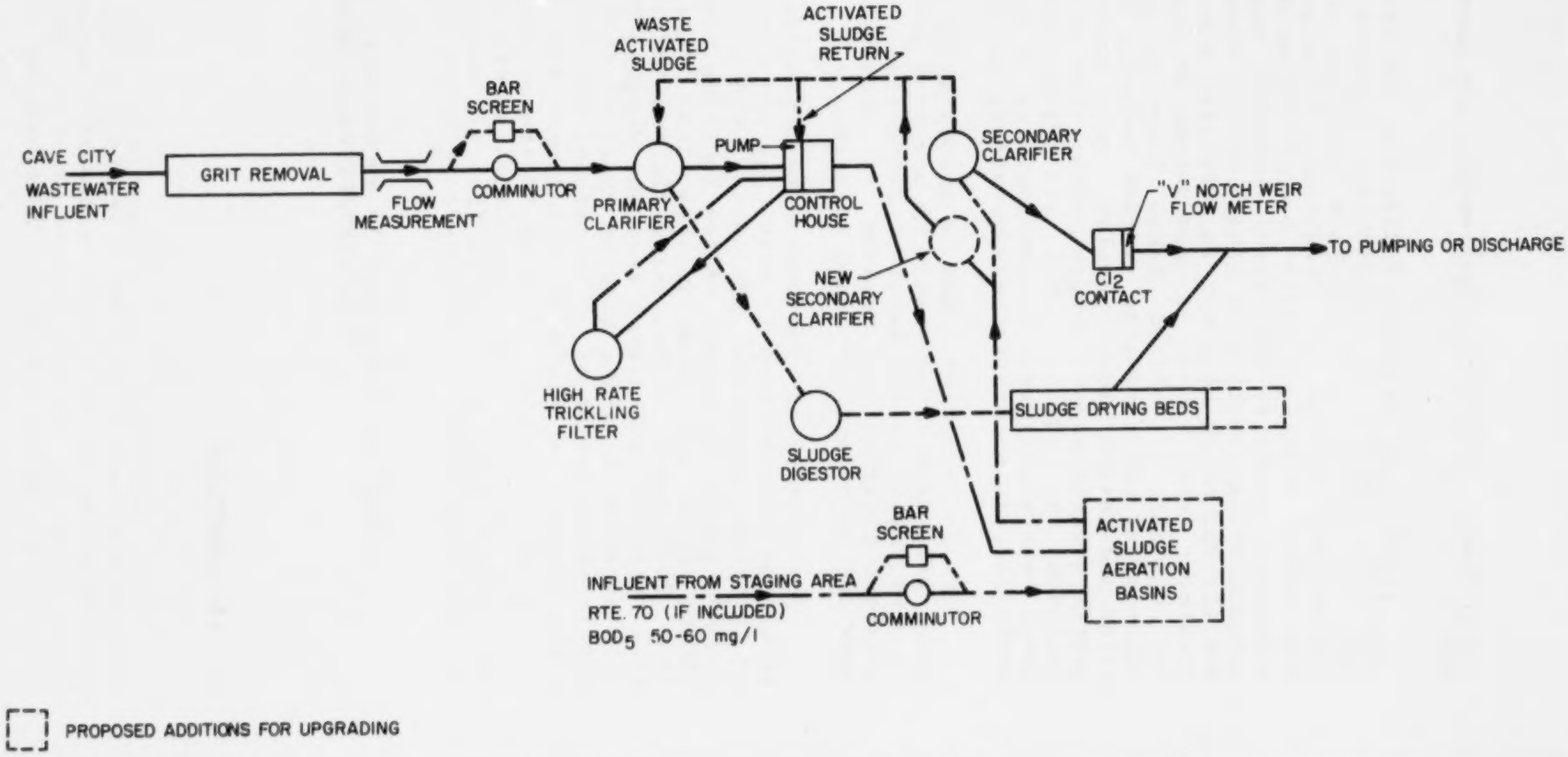
CAVE CITY WASTEWATER INFLUENT
GRIT REMOVAL
FLOW MEASUREMENT
BAR SCREEN
COMMINUTOR
WASTE ACTIVATED SLUDGE
PRIMARY CLARIFIER
PUMP
ACTIVATED SLUDGE RETURN
CONTROL HOUSE
HIGH RATE TRICKLING FILTER
SLUDGE DIGESTOR
NEW SECONDARY CLARIFIER
SECONDARY CLARIFIER
"V" NOTCH WEIR FLOW METER
Cl2 CONTACT
TO PUMPING OR DISCHARGE
SLUDGE DRYING BEDS
BAR SCREEN
INFLUENT FROM STAGING AREA
RTE. 70 (IF INCLUDED)
BOD5 50-60 mg/l
COMMINUTOR
ACTIVATED SLUDGE AERATION BASINS
PROPOSED ADDITIONS FOR UPGRADING

FIGURE III

GENERAL PROCESS FOR UPGRADING HORSE CAVE WASTEWATER TREATMENT PLANT

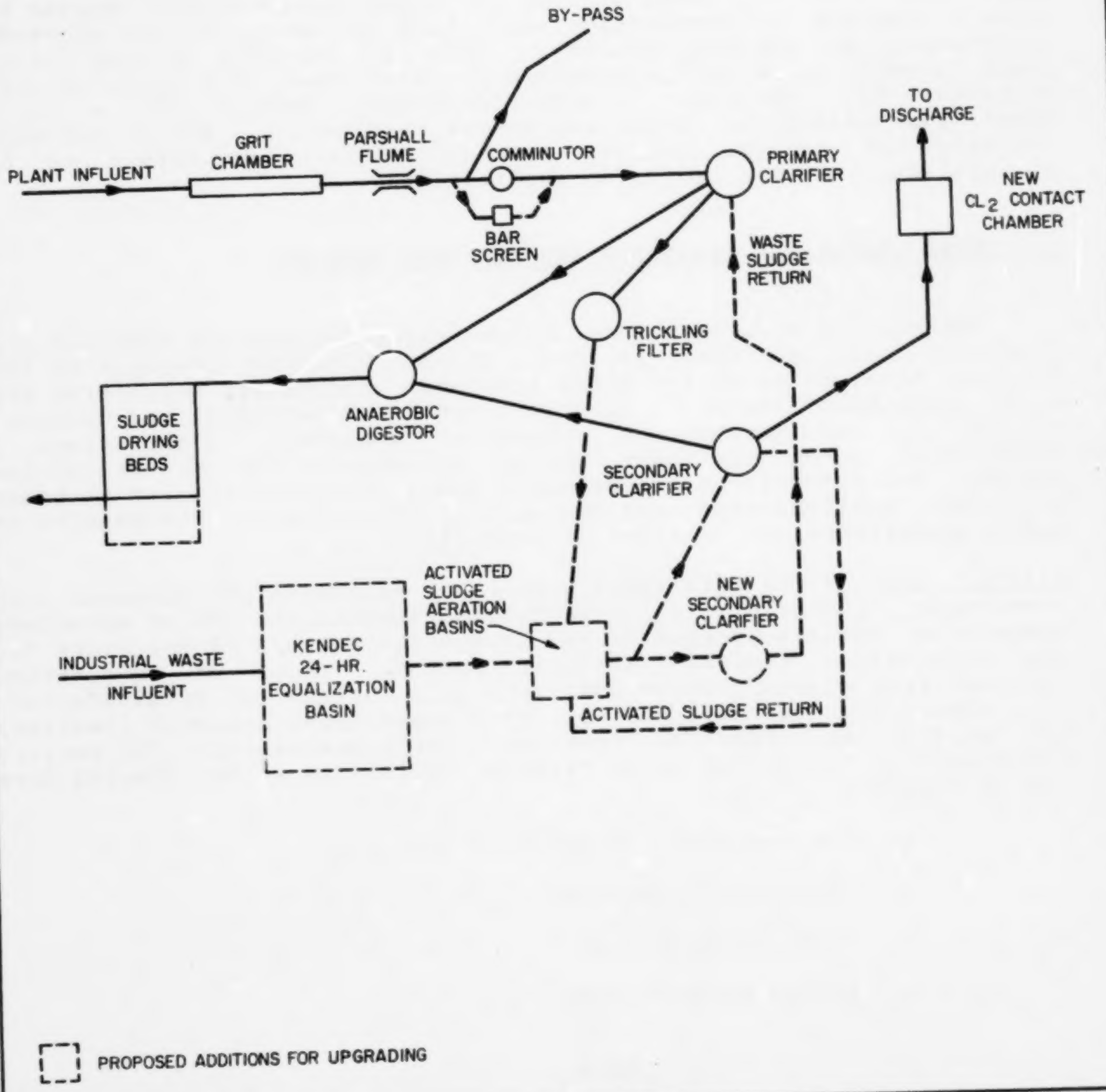
BY-PASS
TO DISCHARGE
PLANT INFLUENT
GRIT CHAMBER
PARSHALL FLUME
COMMINUTOR
PRIMARY CLARIFIER
NEW CL2 CONTACT CHAMBER
BAR SCREEN
WASTE SLUDGE RETURN
TRICKLING FILTER
SLUDGE DRYING BEDS
ANAEROBIC DIGESTOR
SECONDARY CLARIFIER
ACTIVATED SLUDGE AERATION BASINS
NEW SECONDARY CLARIFIER
INDUSTRIAL WASTE INFLUENT
KENDEC 24-HR. EQUALIZATION BASIN
ACTIVATED SLUDGE RETURN
PROPOSED ADDITIONS FOR UPGRADING

FIGURE III-5

ageable number. The purpose of this section is to describe the local and joint wastewater treatment and disposal options evaluated and to present the recommended options as well as the rationale for the selection of each.

The basis of evaluation of all the local and joint wastewater treatment options is an abbreviated cost-effectiveness analysis which includes net present worth costs, environmental impacts (natural environment) and system operability. This section provides a discussion of the results of the analyses, however, the details of the analyses are presented in Appendix III.

All the elements of a cost-effectiveness analysis are described in detail in the following section (Alternatives Evaluation). The cost-effectiveness analyses used in the process of evaluating these local and joint treatment options is termed "abbreviated" because it doesn't include a quantitative evaluation of impacts on the man-made environment or implementability. This is because, in most cases, there appears to be little significance associated with these considerations for different treatment/disposal options for a given population center or population center combination. Where implementability or impacts on the man-made environment appear to be significant, they are evaluated qualitatively.

2. LOCAL WASTEWATER TREATMENT AND DISPOSAL OPTIONS

Options for providing local wastewater treatment and disposal are presented and described in Table III-3. With the exception of the Staging Area, at least two local treatment options are considered for each population center. In order that local treatment and disposal options be incorporated in wastewater management alternatives, a recommended local treatment option is selected for each population center. The selection of recommended local treatment options is based on cost, environmental and operability evaluations. The results of these evaluations are provided in Appendix III.

Staging Area - The only local wastewater treatment and disposal plan considered appropriate for the Staging Area is the use of waterless composting toilets because of the severe limitations of the sight for any alternative treatment/disposal method. Based on information received from Clivus Multrum USA, Inc. (a waterless toilet manufacturer), waterless composting toilets, even under heavy seasonal loadings, can provide an effective treatment for human wastes. The primary advantages to the use of these types of facilities at the Staging Area are as follows:

1. Low construction and operating costs
2. Wastewater reduction
3. Water conservation
4. Energy conservation

TABLE III-3
LOCAL WASTEWATER TREATMENT AND DISPOSAL OPTIONS

Population Center	Option Identification	Description of Treatment	Disposal Method and Location	Proposed Action
Park City	PC-1	Advanced Secondary[1] treatment by extended aeration.	Spray irrigation land application system south of the business section of Park City.	Construction of the following: . Conventional wastewater collection system. . Extended aeration "package" wastewater treatment plant (0.08 mgd). . Spray irrigation system.
*Park City	PC-2	Septic tank/soil absorption systems. Individual systems to serve homes and business establishments that presently discharge directly to groundwater. A community soil absorption system to serve the business section of Park City where individual systems are not feasible.	Land application by soil absorption systems in soils in and around Park City.	Construction of the following: . Conventional and alternate on-lot wastewater treatment and disposal systems. . Small community low pressure sewer wastewater collection system to collect and convey wastewater from individual septic tanks to a community soil absorption system.
*Staging Area	SA-1	Composting waterless toilets septic tank/absorption system for greywater from hand-washing, etc.	Land spreading of composted wastes. Land application by soil absorption for greywater.	Installation of the following: . One hundred fifty composting toilets. . Septic tank and greywater roughing filter treatment system. . Soil absorption system.
Horse Cave	HC-1	Advanced secondary treatment by upgrading existing Horse Cave wastewater treatment plant. (Class I reliability). Equalization for industrial wastewaters.	Discharge to Hidden River Cave at a new site downstream from the confluence of the east and south branches.	. Make necessary repairs to existing facilities. . Addition of duplicate treatment units for reliability and primary clarifier, trickling filter, secondary clarifier and heated anaerobic digester. . Addition of activated sludge second-stage biological treatment system. . Construction of a new outfall to Hidden River Cave. . Construction of industrial wastewater handling facilities.
Horse Cave	HC-2	Secondary treatment by upgrading existing Horse Cave wastewater treatment plant. (Class III reliability). Equalization for industrial wastewaters.	Land application during the dry season and subsurface discharge to Hidden River Cave at a new site downstream from the confluence of the east and south branches.	. Make necessary repairs to existing facilities. . Addition of activated sludge second stage biological treatment system and a secondary clarifier. . Construction of a land application system. . Construction of a new outfall to Hidden River Cave. . Construction of industrial wastewater handling facilities.
Horse Cave	HC-3	Advanced Secondary treatment by extended aeration (Class I reliability). Equalization for industrial wastewater.	Discharge to Hidden River Cave at a new site downstream from the confluence of the east and south branches.	. Abandon the existing Horse Cave wastewater treatment facility. . Construction of a 0.33 mgd oxidation ditch extended aeration facility.

[1] Secondary treatment is defined by the EPA as 30 mg/l BOD_5 and 30 mg/l TSS. However, extended aeration is expected to provide a higher quality effluent. (10-20 mg/l BOD_5 and 20-30 mg/l TSS)

*Option to be included in wastewater management alternatives.

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TABLE III-3 (Cont'd.)
LOCAL WASTEWATER TREATMENT AND DISPOSAL OPTIONS
(Continued)

Population Center	Option Identification	Description of Treatment	Disposal Method and Location	Proposed Action
*Horse Cave	HC-4	Secondary treatment by upgrading existing Horse Cave wastewater treatment plant. (Class III reliability). Equalization for industrial wastewaters.	Discharge to the Green River near Lawler Bend via force main.	. Make necessary repairs to existing facilities. . Addition of activated sludge second-stage biological treatment system and a secondary clarifier. . Construction of pumping station and force main to convey treated wastewater to the Green River. . Construction of industrial wastewater handling facilities.
Cave City	CC-1	Advanced Secondary treatment by extended aeration (Class I reliability).	Discharge to subsurface at the existing site tributary to the Hidden River Cave system.	. Abandon the existing Cave City wastewater treatment plant. . Construction of a new 0.37 mgd oxidation ditch extended aeration facility.
Cave City	CC-2	Secondary treatment by upgrading existing Cave City wastewater treatment facilities. (Class III reliability).	Land application during the dry season and subsurface discharge at the existing site during wet season.	. Make necessary repairs to existing facilities. . Conversion of anaerobic digester to aerobic operation . Addition of an activated sludge second-stage biological treatment system and a secondary clarifier. . Construction of a land application system.
*Cave City	CC-3	Advanced Secondary treatment by upgrading existing Cave City facilities. (Class I reliability)	Discharge to subsurface at the existing site tributary to the Hidden River Cave system.	. Make necessary repairs to existing facilities. . Addition of duplicate treatment units for reliability; primary clarifier, trickling filter, secondary clarifier and heated anaerobic digester. . Addition of activated sludge second-stage biological treatment system. . Construction of a new outfall to Hidden River Cave. . Construction of industrial wastewater handling facilities.
*Munfordville	MN-1	Secondary treatment by Munfordville extended aeration plant for existing wastewater collection service area. On-lot septic tank/soil absorption wastewater treatment for homes and businesses outside the existing wastewater collection service area.	Discharge to the Green River via existing outfall. Land application by soil absorption.	. Construction of conventional and alternate on-lot wastewater treatment and disposal systems.
Munfordville	MN-2	Secondary treatment by existing Munfordville extended aeration facility with additional solids handling facilities.	Discharge to the Green River via existing outfall.	. Construction of a low pressure sewer system to expand wastewater collection service to the entire municipal population. . Construction of aerobic digester and sludge drying beds.

[1] Secondary treatment is defined by the EPA as 30 mg/l BOD_5 and 30 mg/l TSS. However, extended aeration is expected to provide a higher quality effluent. (10-20 mg/l BOD_5 and 20-30 mg/l TSS)

*Option to be included in wastewater management alternatives

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Since the Staging Area has not been constructed yet, a substantial cost savings is expected since the toilet facilities are part of the treatment costs, eliminating the need to construct conventional plumbing toilet facilities and a separate wastewater treatment plant as well. In addition, the manpower required to maintain the facilities is about the same as required to maintain conventional restrooms, eliminating the need for additional wastewater treatment plant operators. Furthermore, power consumption by the composting facilities is negligible compared to that of a wastewater treatment plant.

Using this system, the only wastewater expected to be generated at the Staging Area would result from hand washing, general clean-up and drinking fountain use. This "greywater" is to be treated using a septic tank/soil absorption system.

The main disadvantage of using waterless composting toilets is that the concept is still relatively new and generally untested for such a large scale application. There may be some additional disadvantages associated with the size of the facilities and the management efforts required to maintain working toilets. Since the composting tanks are large, the area required for restroom facilities is substantially larger than that required using conventional plumbing. This may add some expense to the design of the Staging Area facilities. Because the composting toilets need to be "rested", restroom facilities will be operated by schedule, requiring additional manpower to implement these operations.

Park City - Because there are no surface or sub-surface receiving waters in Park City area, only wastewater treatment/disposal options involving land application of wastewater are considered, spray irrigation in option PC-1 and septic tank/soil absorption in PC-2. The recommended local treatment option for Park City is PC-2.

The soils in the Park City area appear to be generally suitable for septic tank/soil absorption systems according to Soil Conservation Service (SCS) information. For this reason, it is expected that properly designed and installed septic tank/soil absorption systems will provide adequate wastewater treatment to protect free-flowing groundwaters in the Park City area. The impacts of this system on the natural environment are considered to be positive since soil absorption treatment represents a major improvement over the existing methods of direct discharge of raw wastewater to the sub-surface. In fact, based on natural environmental impacts, the soil absorption system of PC-2 ranks only slightly less favorable than the spray irrigation system of PC-1, primarily because of the possible negative impacts to diffuse groundwater which would not occur with spray irrigation of a high quality effluent.

Although environmental considerations slightly favor PC-1 (treatment and spray irrigation), the small increment of environmental benefit does not appear to be significant enough to warrant the increased costs associated with the construction and operation of a wastewater collection system, treatment plant and spray irrigation system. The net present worth of PC-1 is estimated to be $2,662,000 (including 15% adjustment for spray irrigation) compared to an estimated net present worth of $1,243,000 for PC-2, more than twice the costs. Local annual costs are estimated to be $104,000 for PC-1 versus $87,000 for PC-2.

In addition to cost and environmental factors, operability and implementability of the recommended system must also be considered. The most significant problem that may be associated with option PC-2 is maintaining adequate operation of individual on-lot treatment systems. Even though septic tank/soil absorption is a reliable method of providing wastewater treatment under suitable conditions, these systems must be adequately maintained in order to be effective. The use of on-lot systems as the means for wastewater treatment in Park City would require the town to insure that individual system owners provided necessary maintenance. This problem is closely associated with implementability in that there first must be a governmental mechanism to require installation of properly designed individual on-lot systems. However, because of the large difference in costs associated with options PC-1 and PC-2 there appears to be incentive for Park City to implement plans for installation and maintenance of the on-lot systems.

Since it is estimated that only 10-20 percent of Park City wastewaters are treated by properly designed septic tank/soil absorption systems, option PC-2 provides for construction of conventional alternate on-lot systems for all residences and businesses outside of the more densely populated business section of town. For the business section of town, the plan provides for the construction of a low pressure sewer system to transport wastewater from individual septic tanks (STEP system) to a community soil absorption field. (The location of the proposed system is provided in Figure III-2.)

Cave City - There are three local wastewater treatment/disposal options considered for Cave City as indicated in Table III-3. These are (1) advanced secondary treatment by extended aeration and discharge to Hidden River Cave tributary at existing site (CC-1), (2) secondary treatment by upgrading the existing Cave City treatment plant and disposal by seasonal land application or subsurface discharge (CC-2), and (3) advanced secondary treatment by upgrading the existing Cave City wastewater treatment plant and discharge to Hidden River Cave tributary at the existing site (CC-3). If it is assumed that no transmission costs are associated with the spray irrigation option (based on using land adjacent to the existing plant site), all three of these options are competitive in a cost-effectiveness analysis.

Because a high quality effluent is assumed for the advanced secondary treatment facilities, the environmental impact ratings of spray irrigation versus subsurface disposal are very close. It is assumed that the continuous subsurface discharge of a high quality effluent will not have significantly different environmental impacts than runoff from land application of a lower quality effluent during dry seasons and subsurface discharge of this effluent during wet seasons. For this reason, the choice of a recommended option is based primarily on cost and operability.

The least cost option, both in terms of net present worth and annual local costs, is CC-3 which provides for upgrading the existing

Cave City treatment plant and sub-surface discharge at the existing site. The operability of this option is considered to be greater than the seasonal spray irrigation. This is primarily because of limits to flexibility and reliability of spray irrigation systems. Treatment by spray irrigation is considered to be generally less reliable since the proper functioning of the spray site is so critical and not as predictable as mechanical treatment processes. In the case of CC-2, a failure of the spray site during the dry season would necessitate pumping secondary treated wastewater to the subsurface.

Although considered to have higher operability than seasonal spray irrigation, the operability of CC-3 is less than CC-1, the new extended aeration treatment facility. The new plant is considered to be more reliable because of its simplicity of operation and equipment improvements. In addition, new facilities are generally easier to maintain and have more built-in operational flexibility. However, the net present worth of the new extended aeration facility (CC-1) is estimated to be $1,605,000 compared to $1,441,000 for the upgraded existing plant (CC-3). (Annual costs are approximately equal.)

Comparing costs and operability of CC-1 and CC-2, it appears that the costs consideration is the more significant factor. The recommended local wastewater treatment/disposal option is, therefore, CC-3 based on costs, environmental and operability considerations. In addition, it is expected that public sentiment would favor maximum use of existing facilities.

Horse Cave - Four local wastewater treatment/disposal options are considered for Horse Cave as indicated in Table III-1. These are briefly (1) Class I reliability advanced secondary treatment (by upgrading the existing Horse Cave treatment facility) and discharge to Hidden River Cave downstream from the confluence of the east and south branches (HC-1), (2) Class III reliability secondary treatment (by upgrading the existing Horse Cave treatment plant) and disposal by seasonal land application or subsurface discharge to Hidden River Cave (HC-2), (3) Class I reliability advanced secondary treatment (by a new extended aeration facility) and discharge to Hidden River Cave downstream of the east-south branch confluence (CC-3), and (4) Class III reliability secondary treatment (by upgrading the existing Horse Cave treatment plant) and discharge to the Green River via force main (HC-4).

Comparison of estimated net present worth and local annual costs indicates that cost differences for these options are minimal. The highest net present worth estimate ($2,618,000 for CC-4) is only about 10 1/2 percent more than the lowest estimate ($2,368,000 for CC-1). Because these costs are so competitive, the choice of a recommended local treatment/disposal option for Horse Cave is governed primarily by environmental considerations. The recommended local option for Horse Cave, therefore, is CC-4, Class III reliability secondary treatment (by upgrading the existing Horse Cave wastewater treatment facility) and discharge to the Green River near Lawler Bend since significant environmental benefits and possible economic benefits are realized for a relatively small cost increase. Removal of the Horse Cave wastewater discharge entirely from Hidden River Cave is considered to be the optimum solution from an environmental standpoint. Water quality in Hidden River Cave should increase substantially while

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the Green River water quality should be relatively unaffected because of the large assimilative capacity of the river. In addition, because wastewater discharge is no longer subject to the severe limitations of maintaining subsurface water quality, the potential for industrial and commercial growth is increased.

There are some possible negative impacts that accompany this recommendation. If growth in Horse Cave stimulated by adequate wastewater treatment is uncontrolled, large volumes of wastewater from the Horse Cave discharge may begin to degrade water quality in the Green River. In addition, runoff from urban-suburban development may also adversely affect Hidden River Cave as all street drainage in Horse Cave is discharged to the Hidden River Cave system.

With respect to urban-suburban runoff, there is one additional consideration regarding this alternative. Removing the discharge from Hidden River Cave should substantially improve water quality since the stream is presently heavily polluted. It is uncertain, though, whether continued runoff from Horse Cave will prevent water quality from returning to the point of being adequate for supporting aquatic life or for use as a drinking water supply. If this would be the case, then the best option may be to upgrade the existing facility and continue discharge to the Hidden River Cave. Based on the groundwater sampling program, however, it appears that runoff pollution effects are much less apparent than the Horse Cave wastewater treatment plant discharge. The relatively small expenditure required to make this determination by removing the Horse Cave discharge from Hidden River Cave appears warranted.

Munfordville - Because Munfordville is relatively isolated from the other population centers in the study area, only local plans for wastewater treatment and disposal are considered appropriate. Two options are considered, both involving continued use of the existing Munfordville extended aeration wastewater treatment plant. The first (MN-1) involves maintaining the service of the existing wastewater collection system and continuing use of on-lot wastewater treatment and disposal outside the existing sewerage service area. The second (MN-2) calls for expansion of the wastewater collection system to provide service to the entire municipality. As determined by the 201 Facilities Plan, this requires the addition of another secondary clarifier, and solids handling facilities at the Munfordville wastewater treatment plant.

According to the 201 Plan, there are also certain improvements required at the Munfordville plant regardless of which local option is selected. These involve installation of the following:

- a new flow meter-recorder
- disinfection facilities
- influent and effluent automatic samplers
- equipment to prevent cross connections with municipal water supply

These are not considered as part of the costs of either option MN-1 or MN-2, since they are common to both.

For all practical purposes, the existing wastewater collection system serves all the area which can be served by gravity by the two existing pump stations, one collection pump station and wastewater treatment plant, according to the 201 Facilities Plan. In order for additional areas of the municipality to be provided with wastewater collection service, expansion of the existing system is necessary. Because of the karst topography, this would require several pump stations and force mains in order to use conventional wastewater collection practices. Although the 201 Plan recommendations include expanding the existing collection system by this method, the use of a low pressure sewer system in this area appears to be a more economical method to provide sewerage service to presently unserved areas. There may be, however, some odor problems associated with septic wastewater entering the existing collection system which would require some additional odor control facilities.

Even using costs for low pressure sewers, the cost of providing sewerage service to the entire community of Munfordville is far greater than costs associated with combined use of on-lot facilities. The net present worth of continued use of on-lot systems is estimated to be $843,000 (including allowances for alternate type systems) and the estimated net present worth of the wastewater collection system expansions and treatment plant improvements is $2,229,000. Since soils in Munfordville appear to be generally available for septic-tank soil absorption systems, and since there are no reports of serious problems with malfunctioning septic tanks, it appears that the additional expense of providing sewerage service is not justified. The continued use of on-lot systems in Munfordville is, therefore, the recommended local option. Adoption of this plan would, of course, allow for only low density development in the Munfordville community.

3. JOINT TREATMENT/DISPOSAL OPTIONS

The combinations of study area population centers considered appropriate for joint treatment and/or disposal, because of either potential economic or environmental advantages, are presented in Table II-4, of the Alternatives Development Technical Reference Document. Wastewater treatment and disposal options developed for each of these seven joint treatment/disposal combinations are presented in Table III-4. In order to incorporate these joint treatment/disposal combinations into the wastewater management alternatives, a recommended option is selected for each combination. The recommendations are based on cost, environmental and operability evaluations. The numerical results of these evaluations are provided in Appendix III. This section provides a discussion of the recommended options.

The geographical configuration of the study area population centers is not particularly well-suited for typical regional wastewater treatment facilities where wastewater from several communities is collected and conveyed to a central treatment plant for treatment and disposal. These types of facilities are generally appropriate for

TABLE III-4
DESCRIPTIONS OF JOINT TREATMENT/DISPOSAL OPTIONS

Joint Treatment Configuration: (SA-PC-CC-HC)

Population Centers: Staging Area
Park City
Cave City
Horse Cave

Option Identification: (SA-PC-CC-HC)^1

Conveyance of Staging Area wastewater to Park City wastewater treatment plant by gravity interceptor.

↓

Construction of Park City wastewater collection system; treatment of combined Park City-Staging Area wastewaters by a 0.16 mgd extended aeration plant at Park City; conveyance of Park City treatment plant effluent to Cave City pumping station via force main and gravity interceptor.

↓

First stage biological treatment of Cave City wastewater (0.37 mgd) by optimum use of the existing Cave City wastewater treatment plant; conveyance of combined Cave City-Park City treatment plant effluents from Cave City pump station to regional activated sludge second stage biological treatment at Horse Cave.

↓

First stage biological treatment of Horse Cave wastewater (0.28 mgd since KenDec wastes are not to be included in first stage treatment) by optimum use of the existing Horse Cave wastewater treatment plant. Preliminary treatment of KenDec Wastewater (0.25 mgd) by aerated 24-hour equalization basin. Joint secondary treatment of all wastewaters by a 1.06 mgd activated sludge second stage biological treatment system (Class III reliability); conveyance of treated wastewater to Green River discharge by force main.

Option Identification: (SA-PC-CC-HC)^2*

Conveyance of Staging Area wastewater to Park City wastewater treatment plant by gravity interceptor.

*Option to be included in wastewater management alternatives.

Construction of Park City wastewater collection system; treatment of combined Park City-Staging Area wastewaters by a 0.16 mgd extended aeration plant at Park City; conveyance of Park City treatment plant effluent to Cave City pumping station via force main and gravity interceptor.

Secondary treatment of Cave City wastewater (0.37 mgd) by upgraded existing Cave City wastewater treatment facility (Class III reliability, two stage biological treatment); conveyance of combined Cave City-Park City effluents from Cave City pumping station to Horse Cave discharge pumping station.

Secondary treatment of Horse Cave wastewaters (0.53 mgd) by upgraded existing Horse Cave wastewater treatment facility (Class III reliability, two-stage biological treatment including preliminary treatment of KenDec wastewater (.25 mgd) by an aerated 24-hour equalization basin, first stage biological treatment of remaining 0.28 mgd by optimum use of existing treatment plant and secondary treatment by a 0.53 mgd activated sludge second stage biological treatment step); conveyance of combined effluents from all treatment plants to Green River discharge via force main.

Option Identification: (SA-PC-CC-HC)^3

Conveyance of Staging Area wastewater to Park City wastewater treatment plant by gravity interceptor.

Construction of Park City wastewater collection system; treatment of combined Park City-Staging Area wastewaters by a 0.16 mgd extended aeration plant at Park City; conveyance of Park City treatment plant effluent to Cave City pumping station via force main and gravity interceptor.

Abandon existing Cave City wastewater treatment facilities for use as a pumping station; conveyance of combined Cave City raw wastewater and Park City treatment plant effluent to regional secondary treatment facility at Horse Cave.

Abandon existing Horse Cave wastewater treatment facilities; preliminary treatment of KenDec wastewater by aerated 24-hour equalization basin; joint secondary treatment of all wastewaters by a 1.06 mgd oxidation ditch treatment plant (Class III reliability); conveyance of regional plant effluent to Green River discharge via force main.

Joint Treatment Configuration: (PC-SA-CC-HC)

Population Centers: Park City
Staging Area (including Rt. 70 development)
Cave City
Horse Cave

Option Identification: (PC-SA-CC-HC)^1

Construction of Park City collection system; secondary treatment of Park City wastewaters by 0.08 mgd extended aeration wastewater treatment plant; conveyance of Park City treatment plant; conveyance of Park City treatment plant effluent to pumping station at Chaumont via force main.

Gravity conveyance of wastewater from Staging Area to treatment plant site at Chaumont; gravity conveyance from Rt. 70 development west of Tooney Ridge to wastewater treatment plant site at Chaumont; secondary treatment of Staging Area and Rt. 70 development wastewaters by a 0.105 mgd extended aeration facility at Chaumont; conveyance of combined Staging Area-Park City treatment plant effluents to Cave City pumping station by force main followed by gravity interceptor east of Tookey Ridge (additional Rt. 70 wastewater collected by gravity interceptor to Cave City).

First stage biological treatment of Cave City wastewater (0.37 mgd) by optimum use of the existing wastewater treatment plant; conveyance of combined Park City-Staging Area-Rt. 70 and Cave City partially treated wastewaters by force main and gravity interceptor to regional activated sludge second stage biological treatment system at Horse Cave.

First stage biological treatment of Horse Cave wastewater (.28 mgd since KenDec wastes are not to be included in first stage treatment) by optimum use of existing Horse Cave wastewater treatment plant; preliminary treatment of KenDec wastewater (0.25 mgd) by aerated 24-hour equalization basin; joint secondary treatment of all wastewaters by a 1.11 mgd regional activated sludge second stage biological treatment system (Class III reliability); conveyance of treated wastewater to Green River discharge via force main.

Option Identification: (PC-SA-CC-HC)^{2*}

Construction of Park City collection system; secondary treatment of Park City wastewaters by 0.08 mgd extended aeration wastewater treatment plant; conveyance of Park City treatment plant; conveyance of Park City treatment plant effluent to pumping station at Chaumont via force main.

↓

Gravity conveyance of wastewater from Staging Area to treatment plant site at Chaumont; gravity conveyance from Rt. 70 development west of Tooney Ridge to wastewater treatment plant site at Chaumont; secondary treatment of Staging Area and Rt. 70 development wastewaters by a 0.105 mgd extended aeration facility at Chaumont; conveyance of combined Staging Area-Park City treatment plant effluents to Cave City pumping station by force main followed by gravity interceptor east of Toohey Ridge (additional Rt. 70 wastewater collected by gravity interceptor to Cave City).

↓

Secondary treatment of treated-raw wastewater mixture from Staging Area (0.185 mgd) and Cave City wastewater (0.37 mgd) by upgraded and expanded existing Cave City wastewater treatment plant (Class III reliability, two stage biological treatment including first stage biological treatment of Cave City wastewater only (0.37 mgd) by optimum use of existing treatment plant and secondary treatment by a 0.56 mgd activated sludge second stage biological treatment step); conveyance of Cave City treatment plant effluent to Horse Cave for joint disposal.

↓

Secondary treatment of Horse Cave wastewaters (0.53 mgd) by upgraded existing Horse Cave wastewater treatment facility (Class III reliability, two-stage biological treatment including preliminary treatment of Ken Dec wastewater (.25 mgd) by an aerated 24-hour equalization basin, first stage biological treatment of remaining 0.28 mgd by optimum use of existing treatment plant and secondary treatment by a 0.53 mgd activated sludge second stage biological treatment step); conveyance of combined Cave City-Horse Cave effluents to Green River discharge via force main.

Option Identification: (PC-SA-CC-HC)^{3}

Construction of Park City collection system; secondary treatment of

Park City wastewaters by 0.08 mgd extended aeration wastewater treatment plant; conveyance of Park City treatment plant; conveyance of Park City treatment plant effluent to pumping station at Chaumont via force main.

↓

Gravity conveyance of wastewater from Staging Area to treatment plant site at Chaumont; gravity conveyance from Rt. 70 development west of Toohey Ridge to wastewater treatment plant site at Chaumont; secondary treatment of Staging Area and Rt. 70 development wastewaters by a 0.105 mgd extended aeration facility at Chaumont; conveyance of combined Staging Area-Park City treatment plant effluents to Cave City pumping station by force main followed by gravity interceptor east of Toohey Ridge (additional Rt. 70 wastewater collected by gravity interceptor to Cave City).

↓

Abandon existing Cave City wastewater treatment facilities for use as a pumping station; conveyance of combined Cave City raw wastewater and Staging Area treated-raw wastewater mixture to regional secondary treatment facility at Horse Cave.

↓

Abandon existing Horse Cave wastewater treatment plant; Preliminary treatment of Ken Dec wastewaters by aerated 24-hour equalization basin; joint secondary treatment of all wastewaters by a 1.11 mgd oxidation ditch treatment plant (Class III reliability); conveyance of regional treatment plant effluent to Green River discharge via force main.

Joint Treatment Configuration: (PC-CC-HC)

Population Centers: Park City
Cave City
Horse Cave

Option Identification: (PC-CC-HC)[1]

Construction of Park City wastewater collection system; secondary treatment of Park City wastewater by a 0.08 mgd extended aeration wastewater treatment plant; conveyance of Park City treatment plant effluent to Cave City pump station.

First stage biological treatment of Cave City wastewater (0.37 mgd) by optimum use of the existing wastewater treatment plant; conveyance of combined Park City-Cave City plant effluents to regional activated sludge second stage biological treatment system at Horse Cave for joint treatment.

First stage biological treatment of Horse Cave wastewater (0.28 mgd since Ken Dec wastes are not to be included in first stage treatment) by optimum use of the existing Horse Cave wastewater treatment plant; preliminary treatment of Ken Dec wastewater (0.25 mgd) by aerated 24-hour equalization basin; joint secondary treatment of all wastewaters by a 0.98 mgd activated sludge second-stage biological treatment system (Class III reliability); conveyance of treated wastewater to Green River discharge via force main.

Option Identification: $(PC\text{-}CC\text{-}HC)^2$

Construction of Park City wastewater collection system; secondary treatment of Park City wastewater by a 0.08 mgd extended aeration wastewater treatment plant; conveyance of Park City treatment plant effluent to Cave City pump station.

Abandon the existing Cave City wastewater treatment facilities for use as a pumping station; conveyance of combined Park City effluent and Cave City raw wastewater by force main and gravity interceptor to regional secondary treatment plant at Horse Cave.

Abandon existing Horse Cave wastewater treatment; preliminary treatment of Ken Dec wastewater by aerated 24-hour equalization basin; joint secondary treatment of all wastewaters by a 0.98 mgd oxidation ditch treatment plant (Class III reliability); conveyance of oxidation ditch effluent to Green River discharge via force main.

Option Identification: $(PC\text{-}CC\text{-}HC)^{3*}$

Construction of Park City wastewater collection system; secondary treatment of Park City wastewater by a 0.08 mgd extended aeration wastewater treatment plant; conveyance of Park City treatment plant effluent to Cave City pump station.

↓

Secondary treatment of Cave City wastewater (0.37 mgd) by upgraded existing Cave City wastewater treatment plant (Class III reliability, two-stage biological treatment); conveyance of combined effluents from Park City and Cave City treatment plants to Horse Cave pumping station by force main and gravity interceptor.

↓

Secondary treatment of Horse Cave wastewaters (0.53 mgd) by upgraded existing Horse Cave wastewater treatment facility (Class III reliability, two-stage biological treatment including preliminary treatment of Ken Dec wastewater (.25 mgd) by an aerated 24-hour equalization basin, first stage biological treatment of remaining 0.28 mgd by optimum use of existing treatment plant and secondary treatment by a 0.53 mgd activated sludge second stage biological treatment step); conveyance of combined Cave City and Horse Cave effluents to Green River discharge via force main.

Joint Treatment Configuration: (SA-CC-HC)

Population Centers: Staging Area (including Rt. 70 development)
Cave City
Horse Cave

Option Identification: (SA-CC-HC)^1

Gravity conveyance of wastewater from Staging Area to treatment plant site near Chaumont; gravity conveyance from Rt. 70 development west of Toohey Ridge to the wastewater treatment plant at Chaumont; secondary treatment of Staging Area and Rt. 70 development wastewaters by a 0.105 mgd extended aeration facility at Chaumont; conveyance of Chaumont treatment plant effluent to Cave City pumping station by force main followed by gravity interceptor east of Toohey Ridge; (additional Rt. 70 wastewater collected by gravity interceptor to Cave City.)

↓

First stage biological treatment of Cave City wastewater (0.37 mgd) by optimum use of the existing wastewater treatment plant; conveyance of combined Staging Area-Rt. 70 and Cave City partially treated wastewaters by force main and gravity interceptor to a regional activated sludge second stage biological treatment system at Horse Cave.

↓

First stage biological treatment of Horse Cave wastewater (0.28 mgd since Ken Dec are not to be included in first stage treatment) by optimum use of the existing Horse Cave wastewater treatment plant; preliminary treatment of Ken Dec wastewater by aerated 24-hour equalization basin; joint secondary treatment of all wastewaters by a 1.03 mgd activated sludge second stage biological treatment system (Class III reliability); conveyance of treated wastewater to Green River discharge via force main.

Option Identification: (SA-CC-HC)^2

Gravity conveyance of wastewater from Staging Area to treatment plant site near Chaumont; gravity conveyance from Rt. 70 development west of Toohey Ridge to the wastewater treatment plant at Chaumont; secondary treatment of Staging Area and Rt. 70 development wastewaters by a 0.105 mgd extended aeration facility at Chaumont; conveyance of Chaumont treatment plant effluent to Cave City pumping station by force main followed by gravity interceptor east of Toohey Ridge; (additional Rt. 70 wastewater collected by gravity interceptor to Cave City.)

Abandon existing Cave City wastewater treatment facilities for use as a pumping station; conveyance of Cave City raw wastewater and Staging Area-Rt. 70 partially treated wastewater to regional secondary treatment plant at Horse Cave by force main and gravity interceptor.

Abandon existing Horse Cave wastewater treatment plant; preliminary treatment of Ken Dec wastewater by aerated 24-hour equalization basin; joint secondary treatment of all wastewaters by a 1.03 mgd oxidation ditch treatment plant; conveyance of oxidation ditch effluent to Green River discharge via force main.

Option Identification: (SA-CC-HC)^{3*}

Gravity conveyance of wastewater from Staging Area to treatment plant site near Chaumont; gravity conveyance from Rt. 70 development west of Toohey Ridge to the wastewater treatment plant at Chaumont; secondary treatment of Staging Area and Rt. 70 development wastewaters by a 0.105 mgd extended aeration facility at Chaumont; conveyance of Chaumont treatment plant effluent to Cave City pumping station by force main followed by gravity interceptor east of Toohey Ridge; (additional Rt. 70 wastewater collected by gravity interceptor to Cave City.)

Secondary treatment of treated-raw wastewater mixture from Staging Area (0.105 mgd) and Cave City wastewater (0.37 mgd by upgraded and expanded existing Cave City wastewater treatment plant (Class III reliability, two-stage biological treatment including first stage biological treatment of Cave City wastewater only (0.37 mgd) by optimum use of existing treatment plant and secondary treatment by a 0.48 mgd activated sludge second stage biological treatment step); conveyance of Cave City treatment plant effluent to Horse Cave for joint disposal by force main and gravity interceptor.

↓

Secondary treatment of Horse Cave wastewaters (0.53 mgd) by upgraded existing Horse Cave wastewater treatment facility (Class III reliability, two-stage biological treatment including preliminary treatment of Ken Dec wastewater (.25 mgd) by an aerated 24-hour equalization basin, first stage biological treatment of remaining 0.28 mgd by optimum use of existing treatment plant and secondary treatment by a 0.53 mgd activated sludge second stage biological treatment step); conveyance of combined effluents from Cave City and Horse Cave to Green River discharge via force main.

Joint Treatment Configuration: (CC-HC)

Population Centers: Cave City
Horse Cave

Option Identification: (CC-HC)^1

First stage biological treatment for Cave City wastewater by optimum use of the existing wastewater treatment plant; conveyance of Cave City plant effluent to activated sludge treatment facility in Horse Cave.

↓

First stage biological treatment of Horse Cave wastewater (0.28 mgd since Ken Dec wastes not included in first stage treatment) by optimum use of existing facilities; preliminary treatment of Ken Dec wastewater by aerated 24-hour equalization; joint secondary treatment of Cave City and Horse Cave wastewaters by activated sludge second stage biological treatment system; gravity conveyance of treatment plant effluent to Hidden River Cave discharge below the east-south branch confluence.

Option Identification: (CC-HC)^2

First stage biological treatment for Cave City wastewater by optimum use of the existing wastewater treatment plant; conveyance of Cave City plant effluent to activated sludge treatment facility in Horse Cave.

Same as (CC-HC)^1 except spray irrigation of effluent during dry season.

Option Identification: (CC-HC)^3

Same as (CC-HC)^1.

Same as (CC-HC)^1 except discharge to Green River via force main conveyance.

Option Identification: (CC-HC)^4

Abandon existing Cave City wastewater facilities for use as a raw wastewater pumping station; conveyance of Cave City wastewater to Horse Cave for joint treatment by force main and gravity interceptor.

Abandon existing Horse Cave wastewater treatment facilities; joint secondary (plus) treatment of Cave City and Horse Cave wastewaters by a 0.9 mgd oxidation ditch wastewater treatment facility (Class I reliability); gravity conveyance to Hidden River Cave discharge downstream of the east-south branch confluence.

Option Idenfication: (CC-HC)^5

Same as (CC-HC)^4.

Abandon existing Horse Cave wastewater treatment plant; joint secondary treatment of Cave City and Horse Cave wastewaters by a 0.9 mgd oxidation ditch wastewater treatment facility (Class III reliability); spray irrigation of treatment plant effluent during dry season and gravity conveyance to Hidden River Cave discharge during wet season.

Option Identification: (CC-HC)^6

Same as (CC-HC)^4.

↓

Same as (CC-HC)^5 except discharge to Green River via force main conveyance.

Option Identification: (CC-HC)^7

Secondary treatment of Cave City wastewaters (0.37 gmd) by upgraded existing Cave City wastewater treatment facility (Class III reliability, two-stage biological treatment); conveyance of Cave City effluent to Horse Cave by force main and gravity interceptor for joint disposal.

↓

Secondary treatment of Horse Cave wastewaters (0.53 mgd) by upgraded existing Horse Cave wastewater treatment facility (Class III reliability, two-stage biological treatment including preliminary treatment of Ken Dec wastewater (.25 mgd) by an aerated 24-hour equalization basin, first stage biological treatment of remaining 0.28 mgd by optimum use of existing treatment plant and secondary treatment by a 0.53 mgd activated sludge second stage biological treatment step); spray irrigation of combined Horse Cave-Cave City plant effluents during the dry season and discharge to Hidden River Cave by gravity conveyance during the wet season.

Option Identification: (CC-HC)^{8*}

Same as (CC-HC)^7.

↓

Same as (CC-HC)^7 except discharge of combined effluents to Green River via force main.

Joint Treatment Configuration: (PC-CC)

Population Centers: Park City
Cave City

Option Identification: (PC-CC)^1

Construction of Park City wastewater collection system; secondary treatment of Park City wastewater by a 0.06 mgd extended aeration wastewater treatment plant; conveyance of Park City treatment plant effluent to Cave City for joint disposal.

↓

Secondary treatment of Cave City wastewater (0.37 mgd) by upgraded existing Cave City wastewater treatment plant (Class III reliability); joint disposal of Cave City-Park City effluent by spray irrigation during the dry season and discharge to Hidden River Cave tributary during wet season.

Option Identification: (PC-CC)^2

Same as (PC-CC)^1.

↓

Secondary (plus) treatment of Cave City wastewater (0.37 mgd) by upgraded existing Cave City wastewater treatment plant (Class I reliability, two stage biological treatment); joint disposal of Cave City-Park City effluents by discharge to Hidden River Cave tributary.

Option Identification: (PC-CC)^{3*}

Same as (PC-CC)^1.

↓

Secondary (plus) treatment of Cave City wastewater by 0.37 mgd oxidation ditch wastewater treatment facility; joint disposal of Cave City-Park City effluents by discharge to Hidden River Cave tributary.

Joint Treatment Configuration: (SA-CC)

Popualtion Centers: Staging Area (including Rt. 70 development)
Cave City

Option Identification: $(SA\text{-}CC)_1^*$

Gravity conveyance of wastewater from Staging Area to treatment plant site at Chaumont; gravity conveyance from Rt. 70 development west of Tooney Ridge to Staging Area wastewater treatment plant at Chaumont; secondary treatment of Staging Area and Rt. 70 wastewaters by a 0.105 mgd extended aeration plant at Chaumont; conveyance of Staging Area treatment plant effluent to Cave City via force main followed by gravity interceptor east of Tooney Ridge; (additional Rt. 70 development wastewater collected in gravity interceptor to Cave City).

↓

First stage biological treatment of Cave City wastewater (0.37 mgd) by the existing Cave City wastewater treatment facilities; joint secondary treatment of Cave City and treated-raw wastewater mixture from Staging Area by a 0.5 mgd activated sludge second stage biological treatment system; disposal of plant effluent by spray irrigation during the dry season and discharge to Hidden River Cave tributary during the wet season.

communities located close together and generating relatively large volumes of wastewater. In the Mammoth Cave Study Area, to include Park City and/or the proposed Staging Area with a joint treatment/disposal project with Cave City and Horse Cave requires pumping small volumes of wastewater relatively long distances. The problem associated with this is septic conditions developing in the force main due to long detention times. Although facilities could be provided to maintain wastewater dissolved oxygen levels in the force mains, the expense of chemical addition or mechanical aeration does not appear to be justified when compared with the cost of providing secondary treatment of these relatively small volumes of wastewater prior to pumping as indicated in the 201 plan. In addition, there are potential environmental benefits associated with pumping treated rather than raw wastewater, since force main leaks or breaks would not present as serious a threat to subsurface cave systems. For these reasons, joint treatment/disposal options which involve pumping wastewater from either Park City or the proposed Staging Area include treatment of these wastewaters by extended aeration prior to pumping for joint disposal.

The primary purpose for developing joint treatment/disposal options for the Mammoth Cave area is joint disposal rather than joint treatment since wastewater discharge sites in the study area are severely limited. Discharge of treated wastewater to the Green River is considered the only appropriate disposal method for combining wastewaters from three or more of the population centers. This appears to be the only practical method since year round spray irrigation would require large storage lagoons which are subject to collapse in karst areas and increasing discharge to Hidden River Cave from other population centers in addition to Cave City and Horse Cave appears to be environmentally unacceptable.

Joint Treatment/Disposal Configuration (SA-PC-CC-HC)

There are three options evaluated for this joint treatment/disposal configuration as indicated in Table III-4. In all three options proposed Staging Area wastewater is to be conveyed to Park City by gravity interceptor for joint treatment with Park City wastewater by extended aeration. The plant effluent is then pumped to Cave City for subsequent joint disposal with Cave City-Horse Cave wastewaters. Also common to all three options is the method of disposal, that of pumping treated wastewater from Horse Cave to discharge in the Green River. Because these aspects of wastewater conveyance, treatment and disposal are fixed for this configuration, selection of a treatment scheme to handle Cave City and Horse Cave wastewaters is the only basis for developing the three different options. These are basically treatment options described briefly as follows:

(SA-PC-CC-HC)^1 - Optimum use of existing wastewater treatment facilities at both Cave City and Horse Cave to provide first stage biological treatment. Construction of activated sludge second stage

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biological treatment system for joint secondary treatment.

(SA-PC-CC-HC)^2 - Upgrade both Cave City and Horse Cave treatment plants to provide secondary treatment by addition of activated sludge second stage biological treatment system to each plant.

(SA-PC-CC-HC)^3 - Abandon both the Cave City and Horse Cave treatment plants and construct a new oxidation ditch extended aeration plant at Horse Cave to provide joint secondary treatment for Horse Cave and Cave City.

Based on environmental, cost and operability evaluations as well as some consideration of implementability, the recommended option for the (SA-PC-CC-HC) configuration is (SA-PC-CC-HC)^2. In terms of impacts on the natural environment, (SA-PC-CC-HC)^2 is most favorable since only secondary treated wastewater would be pumped in force mains between population centers, limiting potential adverse effects to subsurface waters due to force main leaks or breaks. Option (SA-PC-CC-HC)^2 also has the lowest net present worth cost. Although the cost differences do not appear to be significant (less than 10 percent) when considering all the costs common to all options; they are significant when considering only the different treatment schemes. The net present worth cost estimate for Cave City-Horse Cave treatment options one (1) and (3) is approximately $3,000,000, approximately 30 percent greater than the $2,300,000 estimated for option (2). Option (SA-PC-CC-HC)^3 is considered to be the most operable of the increased maintainability, flexibility and reliability associated with new treatment facilities. The oxidation ditch is also the simplest to operate. However, these advantages do not appear to be significant enough to warrant the additional costs. Finally, local treatment and joint disposal as proposed in option (SA-PC-CC-HC)^2 appears to be the most implementable since it allows the municipalities of Horse Cave and Cave City to continue to administer and operate their own treatment facilities.

Joint Treatment/Disposal Configurations (PC-SA-CC-HC), (SA-CC-HC) and (PC-CC-HC)

There are three options evaluated for each of these joint treatment/disposal configurations as indicated in Table III-4. Like configuration (SA-PC-CC-HC), treatment and conveyance of proposed Staging Area and/or Park City wastewater is common to all three options considered for any one configuration. Also discharge to the Green River is the only disposal method considered appropriate for each of the configurations. Therefore, the same treatment options presented for configuration (SA-PC-CC-HC) are the basis for the three options considered for each of these joint treatment/disposal configurations. Although volumes of wastewater are different, the most favorable option in all con-

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figurations is to provide secondary treatment at both Horse Cave and Cave City by upgrading the existing plants.

Joint Treatment Disposal Configuration (CC-HC)

More joint wastewater treatment/disposal options are evaluated for Cave City and Horse Cave than for any other joint treatment combination. This is because there are not only different treatment options to consider but also several disposal options are available including spray irrigation, discharge to Hidden River Cave and discharge to the Green River.

Of the eight options evaluated, (CC-HC)^8 is the most favorable according to environmental considerations. Local secondary treatment by Cave City and Horse Cave followed by pumping to the Green River for discharge provides for removal of existing discharges to the Hidden River Cave system. In addition, secondary treatment prior to pumping reduces potential adverse impacts due to pipeline breaks and leakage. It also appears that continued local treatment at both municipalities may be more easily implemented than a joint treatment plan. However, option (CC-HC)^8 is not the least cost option. It ranks second behind (CC-HC) . Not including costs common to both options, the respective net present worth costs are estimated to be $3,625,000 and $3,287,000. This represents about a 10 percent difference in net present worth costs. There is also approximately $36,000/year greater local annual costs associated with option (CC-HC)^8. These cost differences, however, are not considered to be significant when considering the portential environmental advantages to be realized by removing wastewater discharges from the subsurface.

Joint Treatment Disposal Configuration (SA-CC)^1

There is only one method of wastewater treatment and disposal considered for this joint treatment combination, that of secondary treatment and seasonal spray irrigation. With the potential for heavy growth along Rt. 70 due to sewer installation, it does not appear prudent to plan for subsurface discharge for such a potentially large volume of wastewater. This is especially true since most of these wastewaters are seasonal which may cause problems maintaining a continuously high quality effluent in a biological wastewater treatment system.

Joint Treatment Disposal Configuration (PC-CC)

Three options are evaluated for Park City-Cave City joint wastewater treatment/disposal. All options provide for wastewater collection, secondary treatment and conveyance of Park City wastewater to Cave City for disposal. The differences in the three options is the type of treatment facilities and disposal methods for Cave City: (1) upgrading the existing Cave City treatment plant to provide secondary treatment (PC-CC)^{1} (Class III reliability) with seasonal spray irrigation (PC-CC); (2) upgrading the existing plant to provide secondary-plus treatment (Class I reliability) with discharge to Hidden River Cave tributary; and (3) constructing a new oxidation ditch extended aeration plant to provide advanced secondary treatment (Class I reliability).

Evaluating these three options differs from the approach used in evaluating proposed Staging Area-Cave City joint treatment/disposal as only the seasonal spray irrigation option is considered. Subsurface disposal is still considered as an option in this case because the potential for uncontrolled growth in the Park City area does not appear to be as great as that along Rt. 70. In addition, wastewater flows from Park City are to be treated prior to conveyance and do not require treatment in a Cave City system. Wastewaters from Rt. 70 and the proposed Staging Area, however, require additional treatment at Cave City. Since these flows are expected to have extreme seasonal variations, maintaining consistent treatment in biological systems may be difficult.

The three options evaluated for Park City-Cave City joint treatment/disposal are basically the same as those evaluated for local treatment at Cave City. For the reasons discussed previously in the evaluation of local alternatives, (PC-CC)^{2} is the recommended option. Costs are the most significant factor. Considering only those costs not common to all three options, the net present worth of (PC-CC)^{2} estimated to be \$1.44 million as compared with estimated costs of \$1.6 million and \$1.82 million * for options (PC-CC)^{3} and (PC-CC)^{1} respectively. Although estimated annual local costs for (PC-CC)^{2} are approximately the same as those for (PC-CC)^{3}, they are approximately \$13,000/year less than for (PC-CC)^{1} (spray irrigation), even accounting for assumed 85 percent funding for spray irrigation.

PART D. WASTEWATER MANAGEMENT ALTERNATIVES EVALUATION

1. INTRODUCTION

There are eight wastewater management alternatives to be evaluated for the Mammoth Cave area. These are presented in Figure III-6 to III-13 and accompanying descriptions. The wastewater management alternatives correspond with the eight service configurations in the Alternatives Development Technical Refer-

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* The actual net present worth is estimated to be approximately \$2.1 million. This figure represents the cost preference value (\$2.1 million/1.15) specified for cost comparison by EPA Cost-effectiveness Guidelines (40 CFR 35, subpart A.7.a) which stated that land application alternatives must be further considered if net present worth costs are within 115 percent of those of "conventional" systems.

ence Document and include the specific wastewater collection, conveyance, treatment and disposal systems recommended in the previous section.

The basis for the evaluation of these eight wastewater management alternatives is the cost-effectiveness analysis. The cost-effectiveness analysis provides a method for gauging the overall "resource costs" of a particular alternative since it accounts for factors in addition to monetary costs. Although consideration of monetary costs is a major factor in cost-effectiveness analysis, it is only one of four criteria used in the analysis. These four criteria are net present worth costs, impacts on the natural and man-made environment, system operability, and implementability.

Net present worth cost is the total project cost associated with a wastewater management alternative plus the present worth of annual operation and maintenance costs during the planning period, minus the present worth of the salvage value of the treatment/disposal systems at the end of the planning period (year 2000). Impacts on the natural environment include impacts on the aquatic (both surface and subsurface) and terrestrial environment and eco-systems, while impacts on the man-made environment comprise impacts on transportation, public water systems, etc. as well as socio-economic impacts. System operability provides a measure of the ability of a wastewater treatment/disposal system to continuously provide the service for which it is designed and includes such factors as system flexibility, reliability and maintainability. Finally, implementability evaluation provides a method to assess the factors that may affect the implementation of a particular wastewater management plan. This includes political considerations as well as local financial capabilities. It is in this evaluation that local annual costs are examined.

In comparing proposed wastewater management alternatives, only the present worth cost analysis provides a direct monetary comparison for evaluation of the "resource costs". The other three criteria comparisons require some methodology capable of reducing the associate criteria characteristics into a rational, quantitative rating system for relative evaluation of the alternatives. The most cost-effective alternative is the waste treatment management system which this analysis determines to have the lowest net present worth cost unless non-monetary costs are overriding as specified by EPA Cost Effectiveness Guidelines 40 CFR, Part 35, Subpart A.6.a.

WASTEWATER MANAGEMENT ALTERNATIVE 1
(SA-PC-CC-HC) 2 plus MN-1

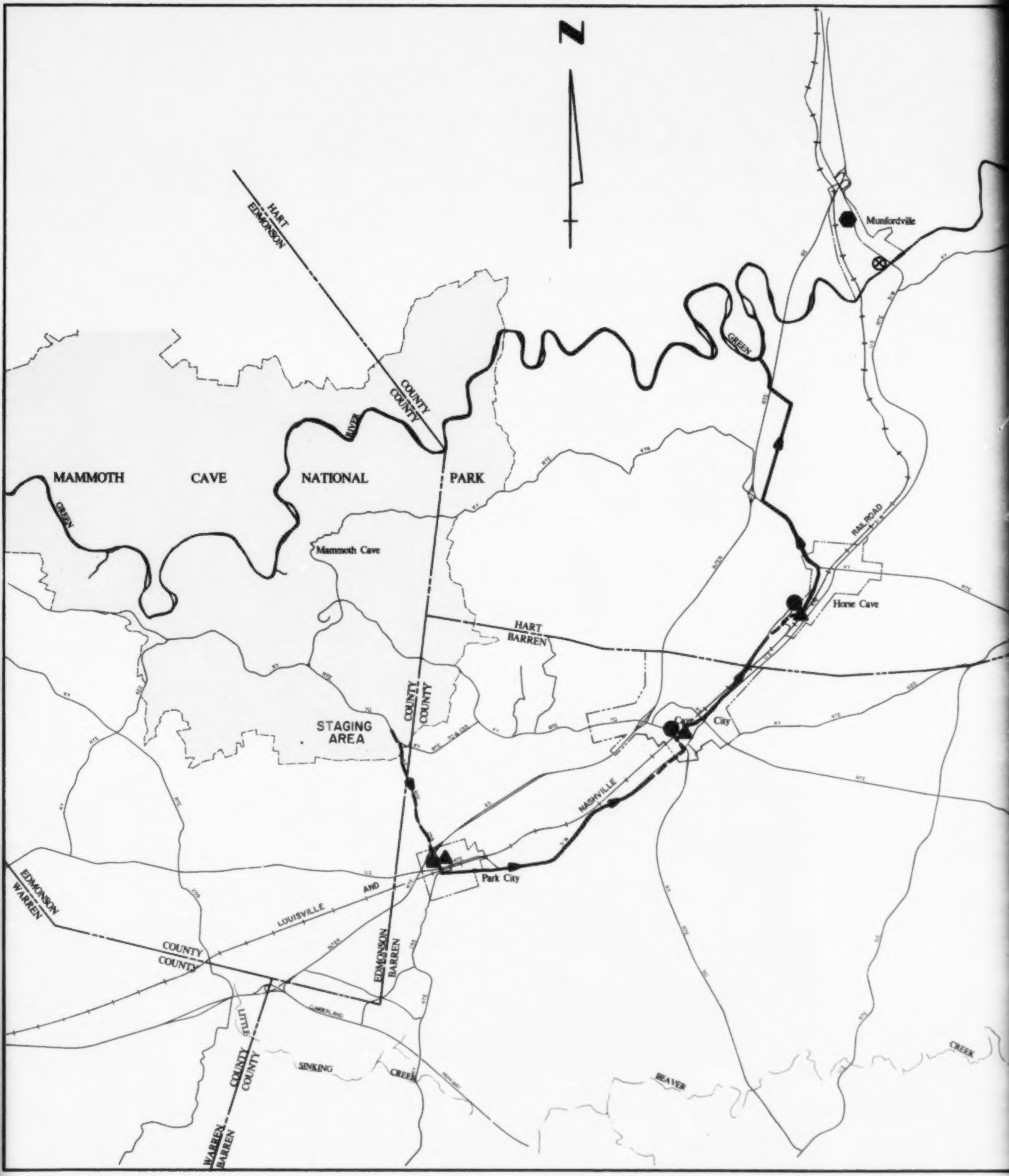
Major Components:

- Gravity sewer from proposed Staging Area to Park City treatment plant
- Wastewater collection system at Park City
- Extended aeration treatment facility (0.16 mgd) at Park City
- Conveyance facilities to transport treated wastewater from Park City to Cave City
- Upgraded (.37 mgd) existing Cave City treatment facility (Secondary treatment, Class III reliability)
- Conveyance facilities to transport treated wastewater from Cave City to Horse Cave
- Upgraded (.53 mgd) existing Horse Cave treatment facility (Secondary treatment, Class III reliability)
- Pump station and force main to commonly treated wastewater to the Green River discharge point
- Additional on-lot treatment systems at Munfordville

WASTEWATER MANAGEMENT ALTERNATIVE 2
(PC-SA-CC-HC) 2 plus MN-1

Major Components:

- Wastewater collection system at Park City
- Extended aeration facility (.08 mgd) at Park City
- Pump station and force main to convey treated wastewater from Park City to Chaumont treatment site pump station
- Gravity lie to convey raw wastewater from the proposed Staging Area to the Chaumont treatment plant site
- Gravity interceptor to convey raw wastewater from Rt. 70 development to the Chaumont wastewater treatment facility
- Extended aeration wastewater treatment facility (0.105 mgd) at Chaumont for Staging Area and Rt. 70 wastewater
- Pump station and force main at Chaumont to convey combined treated wastewaters to gravity interceptor for gravity flow to Cave City along Rt. 70
- Gravity interceptor to convey treated wastewater and additional raw wastewater to Cave City
- Upgraded (.58 mgd) existing Cave City treatment facility (Secondary Treatment) Class III reliability)
- Conveyance facilities to transport treated wastewaters to Horse Cave pumping station
- Upgraded (.53 mgd) existing Horse Cave facility (Secondary treatment, Class III reliability)
- Pump station and force main to convey treated wastewaters to the Green River discharge point
- Additional on-lot treatment systems at Munfordville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CAVE
NATIONAL
PARK
GREEN
RIVER
Mammoth Cave
Munfordville
HART
BARREN
Horse Cave
RAILROAD
Cave City
STAGING
AREA
COUNTY
COUNTY
NASHVILLE
Park City
EDMONSON
WARREN
LOUISVILLE
AND
COUNTY
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SINKING
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BEAVER
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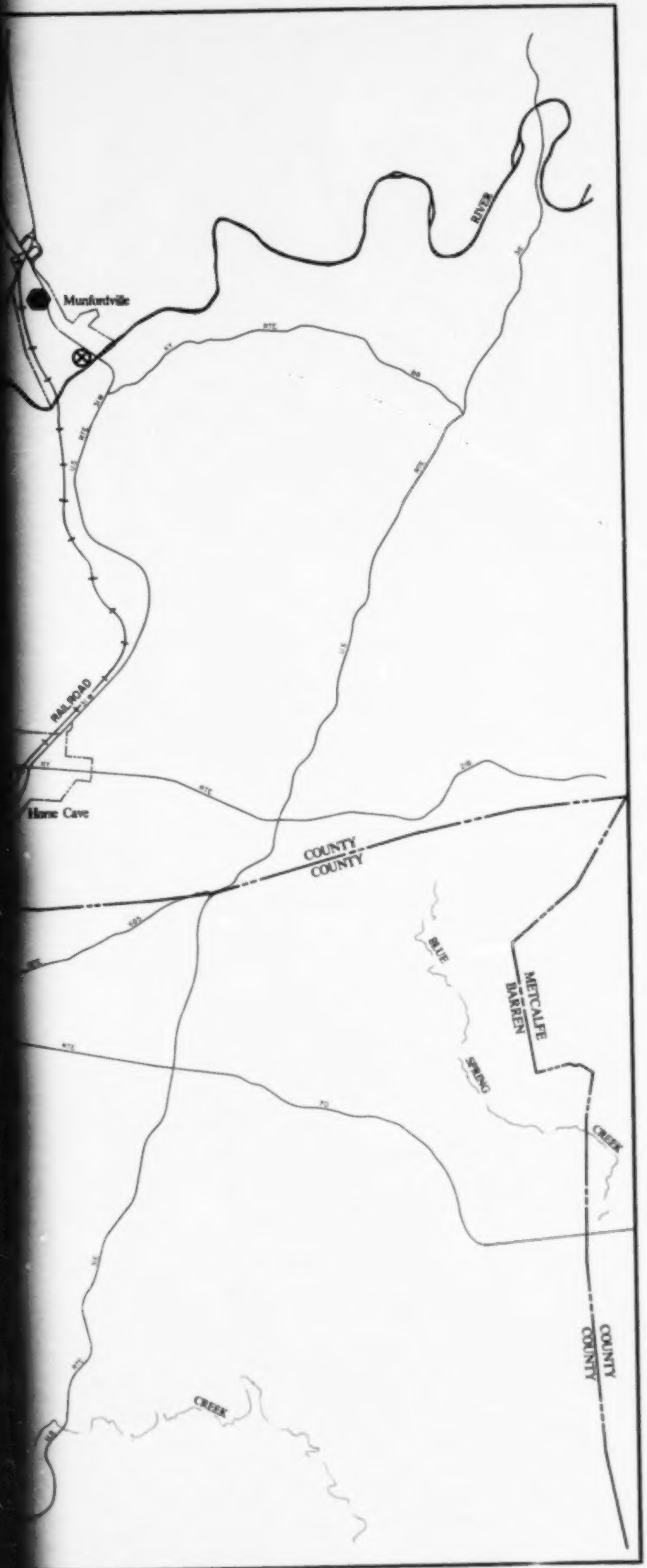

RIVER
Munfordville
RAILROAD
Horse Cave
COUNTY
COUNTY
BLUE
SPRING
CREEK
METCALFE
BARREN
COUNTY
COUNTY
CREEK

LEGEND
▨ MAMMOTH CAVE NATIONAL PARK
FORCE MAIN
GRAVITY INTERCEPTOR
⊗ EXISTING TREATMENT FACILITY
● UPGRADED EXISTING FACILITY
■ NEW WASTEWATER TREATMENT FACILITY
▲ PUMPING STATION
⬢ ON-LOT SYSTEMS

FIGURE III-6

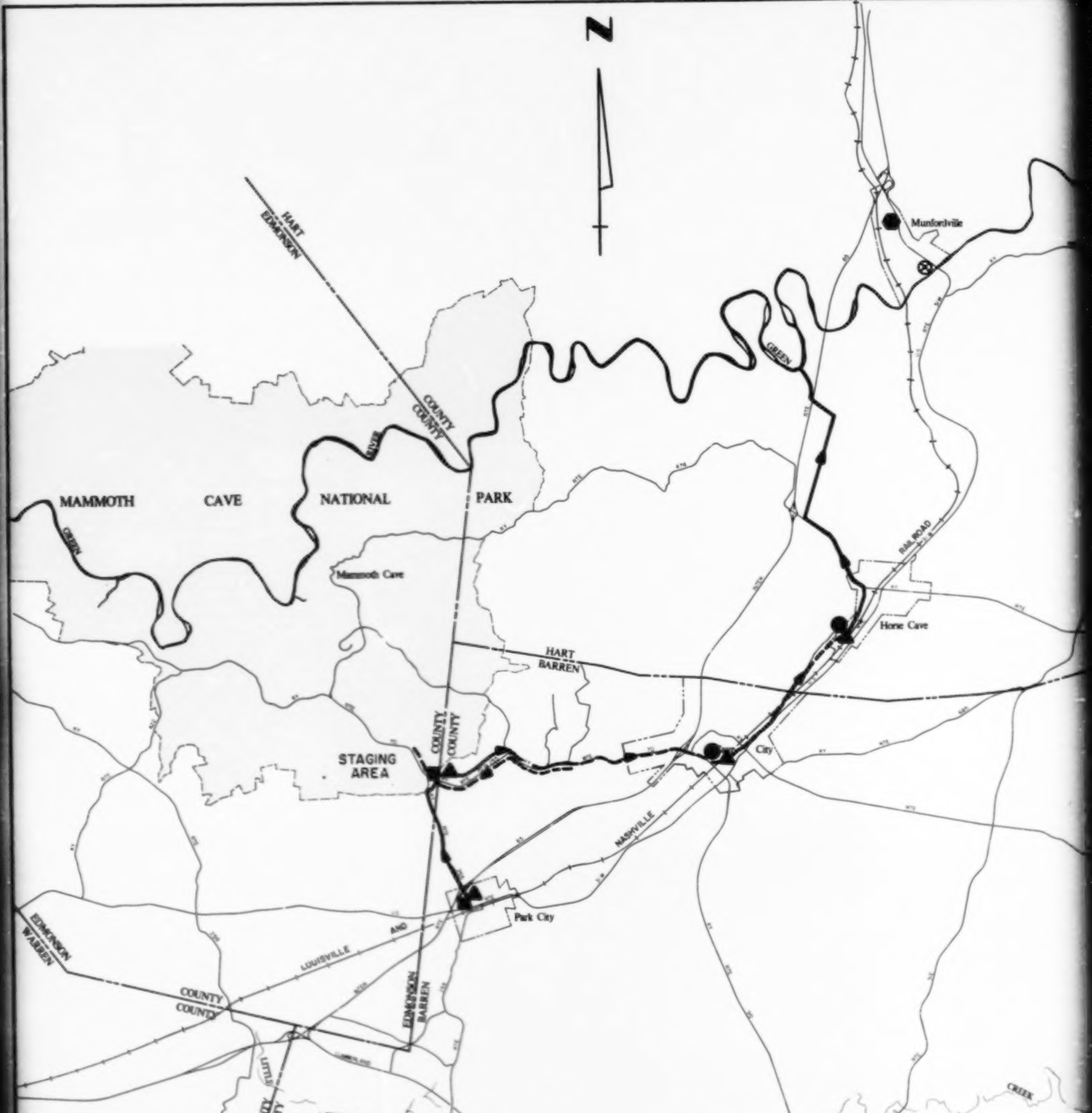
MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

WASTEWATER MANAGEMENT
ALTERNATIVE I
(SA-PC-CC-HC)2 PLUS MN-I

12,000 6000 0 12,000 24,000
Scale In Feet

U.S. Environmental Protection Agency
Region IV Atlanta, Georgia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EDMONSON COUNTY
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MAMMOTH CAVE NATIONAL PARK
Mammoth Cave
RAILROAD
Horse Cave
HART
BARREN
STAGING AREA
COUNTY
COUNTY
City
NASHVILLE
Park City
EDMONSON
WARREN
LOUISVILLE AND
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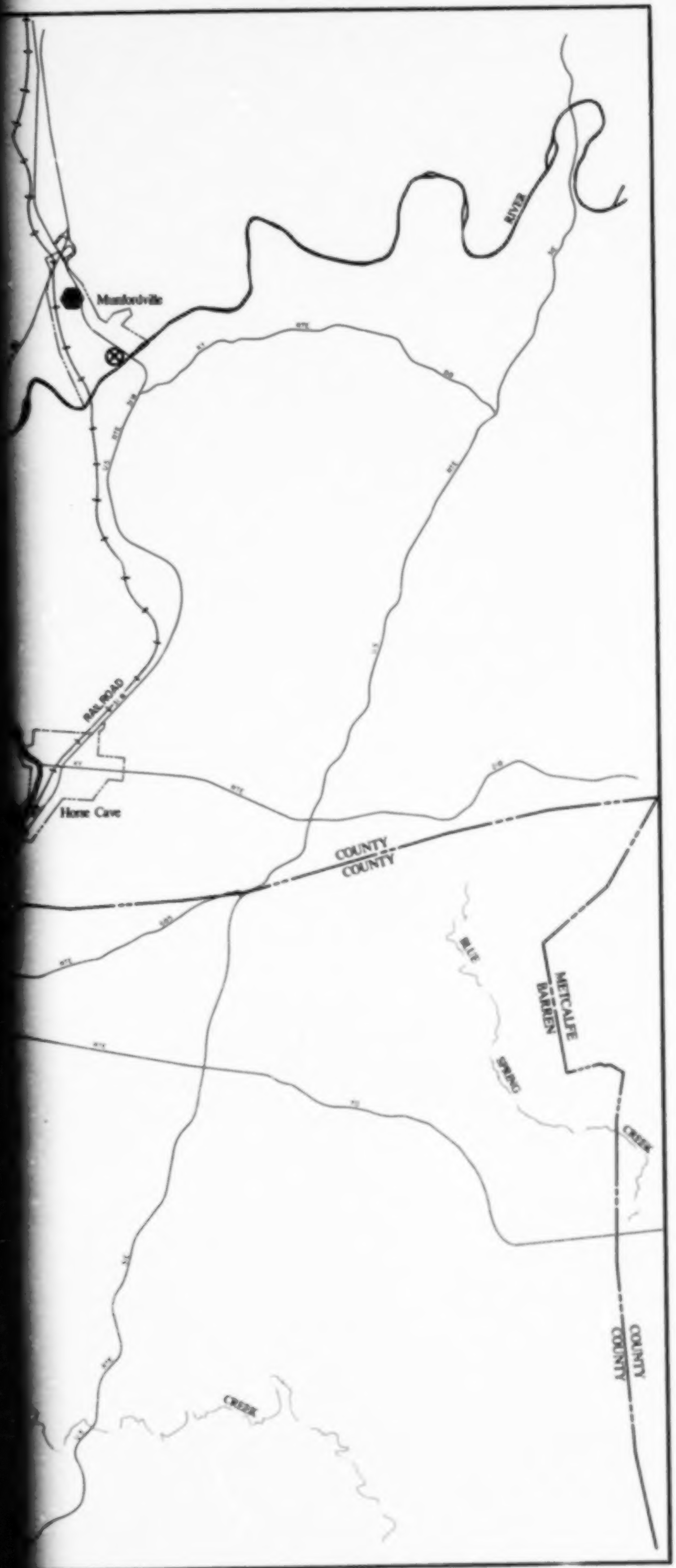
BARREN
SINKING
CREEK
BEAVER
CREEK


RIVER
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Horse Cave
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METCALFE
BARREN
CREEK
COUNTY
COUNTY

LEGEND

- ▨ MAMMOTH CAVE NATIONAL PARK
- —— FORCE MAIN
- ---- GRAVITY INTERCEPTOR
- ⊗ EXISTING TREATMENT FACILITY
- ● UPGRADED EXISTING FACILITY
- ■ NEW WASTEWATER TREATMENT FACILITY
- ▲ PUMPING STATION
- ⬢ ON-LOT SYSTEMS

FIGURE III - 7

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

WASTEWATER MANAGEMENT ALTERNATIVE 2

(PC - SA - CC - HC) 2 PLUS MN - I

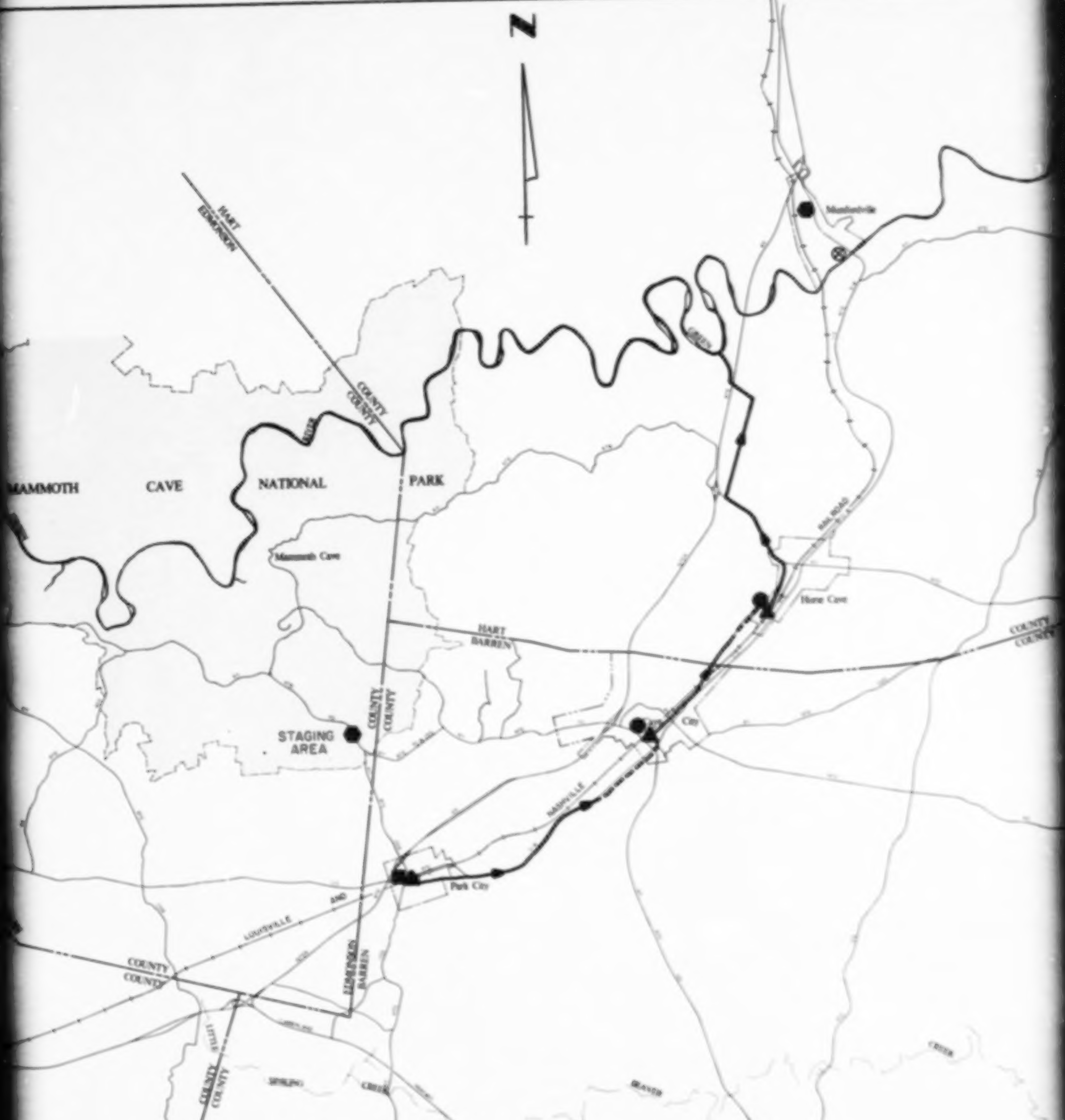
12,000 6000 0 12,000 24,000
Scale In Feet

U. S. Environmental Protection Agency
Region IV Atlanta, Georgia

WASTEWATER MANAGEMENT ALTERNATIVE 3
SA plus (PC-CC-HC) 3 plus MN-1

Major Components:

- Composting waterless toilets - septic tank/soil absorption system for greywater at the proposed Staging Area
- Wastewater collection system at Park City
- Extended aeration wastewater treatment facility (0.08 mgd) at Park City
- Conveyance facilities to transport treated wastewater from Park City to Cave City
- Upgraded (.45 mgd) existing Cave City treatment plant (Secondary treated, Class III reliability)
- Pump station and force main to convey treated wastewater to Green River discharge point
- Additional on-lot systems at Munfordville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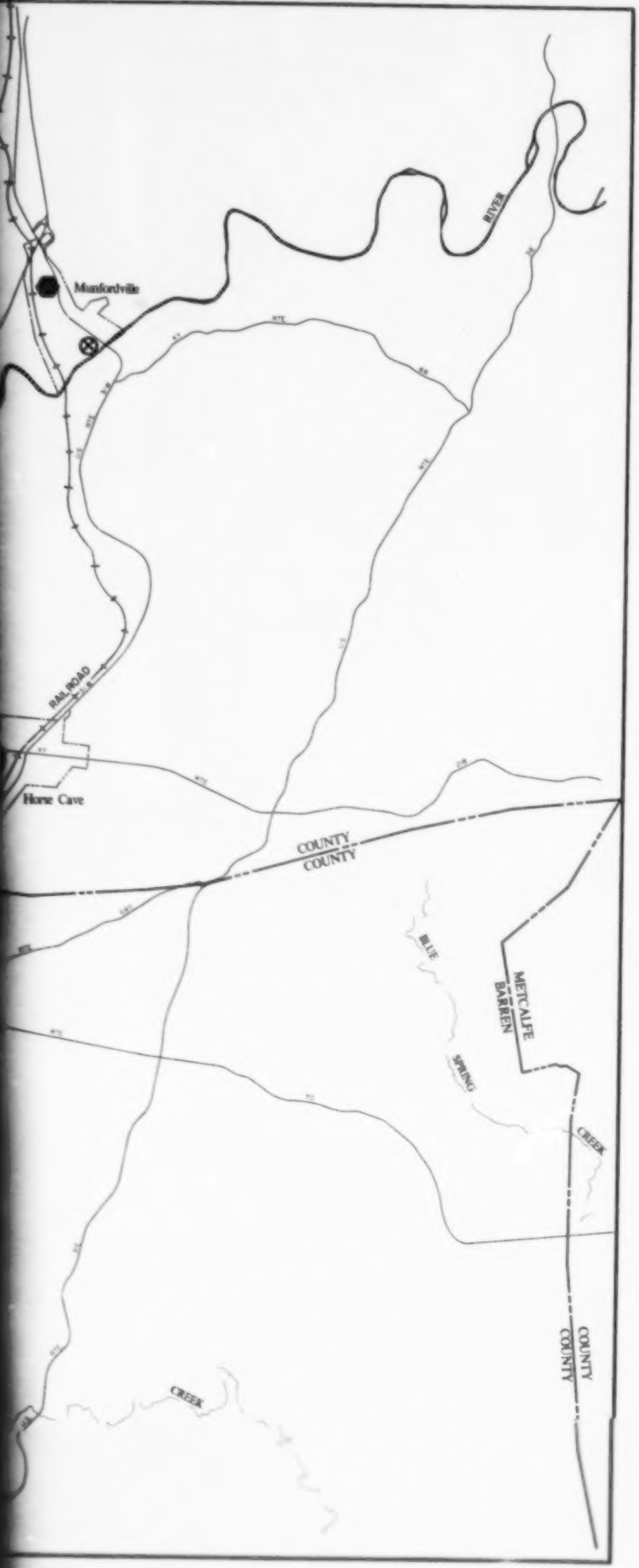
EDMONSON COUNTY
MAMMOTH CAVE NATIONAL PARK
GREEN RIVER
Mammoth Cave
Munfordville
Horse Cave
HART COUNTY
BARREN COUNTY
STAGING AREA
EDMONSON COUNTY
BARREN COUNTY
Cave City
Park City
LOUISVILLE AND NASHVILLE RAILROAD
LITTLE BARREN COUNTY
BARREN COUNTY
SPRING CREEK
BEAVER CREEK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Horse Cave
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COUNTY
COUNTY
CREEK

LEGEND

▨	MAMMOTH CAVE NATIONAL PARK
——	FORCE MAIN
----	GRAVITY INTERCEPTOR
⊗	EXISTING TREATMENT FACILITY
●	UPGRADED EXISTING FACILITY
■	NEW WASTEWATER TREATMENT FACILITY
▲	PUMPING STATION
⬢	ON-LOT SYSTEMS

FIGURE III-8

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

WASTEWATER MANAGEMENT ALTERNATIVE 3

SA PLUS (PC-CC-HC)3 PLUS MN-1

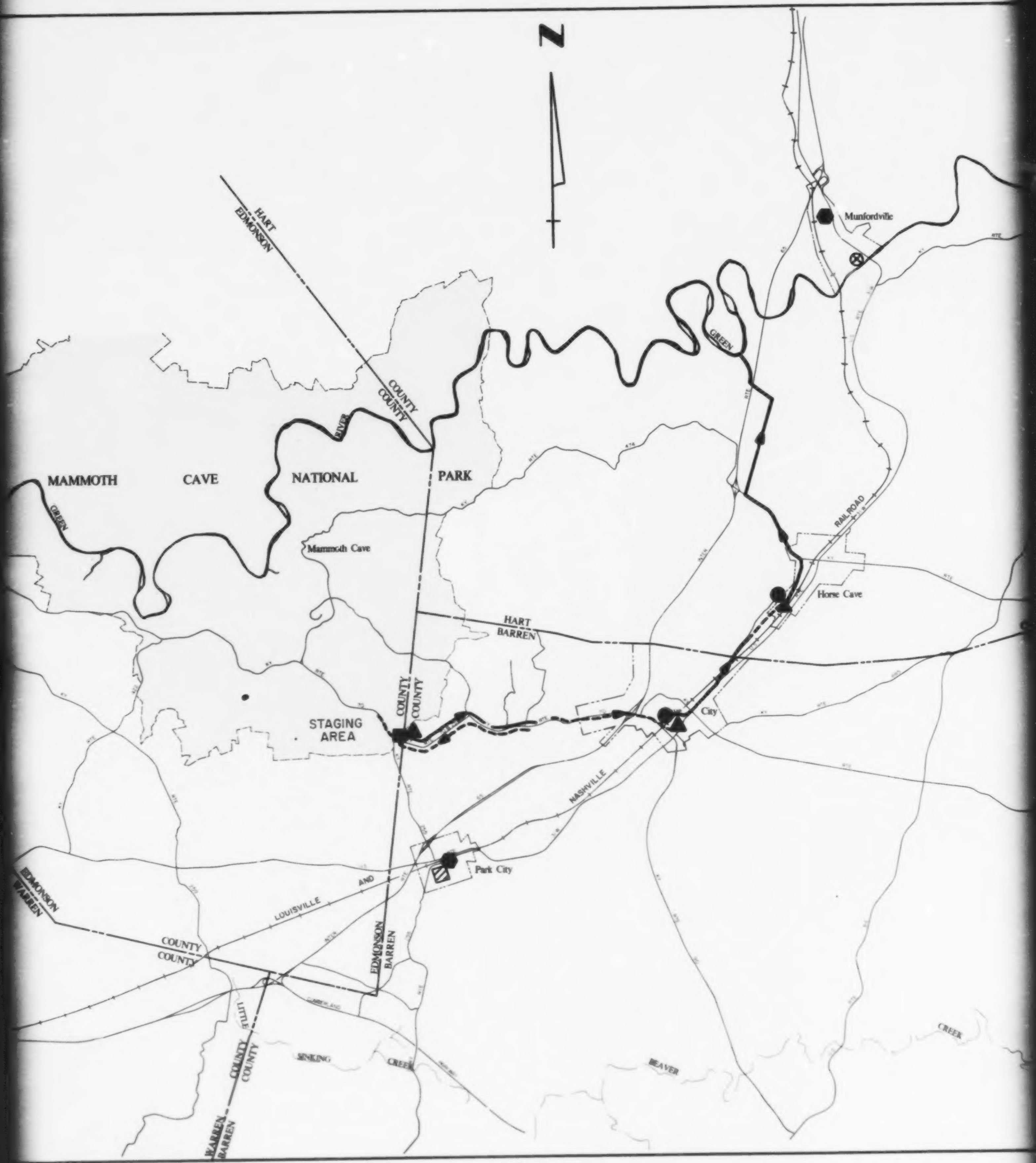
12,000 6000 0 12,000 24,000
Scale In Feet

U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

WASTEWATER MANAGEMENT ALTERNATIVE 4
PC-2 plus (SA-CC-HC) 3 plus MN-1

Major Components:

- Conventional and alternate on-lot treatment systems at Park City
- Small community low pressure sewer system and community soil absorption field at Park City
- Gravity conveyance to transport raw wastewater from proposed Staging Area to Chaumont treatment site
- Gravity interceptor to convey wastewater from Rt. 70 development to the treatment facility at Chaumont
- Extended aeration wastewater treatment facility (0.105 mgd) at Chaumont for Staging Area and Rt. 70 wastewater
- Pump station and force main at Chaumont to convey treated wastewater to gravity interceptor for gravity flow to Cave City along Rt. 70
- Gravity interceptor to convey treated wastewater and additional raw wastewater to Cave City treatment facility
- Upgraded (.5 mgd) existing Cave City treatment plant (Secondary treatment, Class III reliability)
- Gravity and facilities to transport treated wastewater from Cave City to Horse Cave
- Upgraded (.53 mgd) existing Horse Cave treatment facilities (Secondary treatment Class III reliability)
- Pump station and force main to convey treated wastewater to discharge
- Additional on-lot treatment systems at Munfordville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STAGING AREA
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Park City
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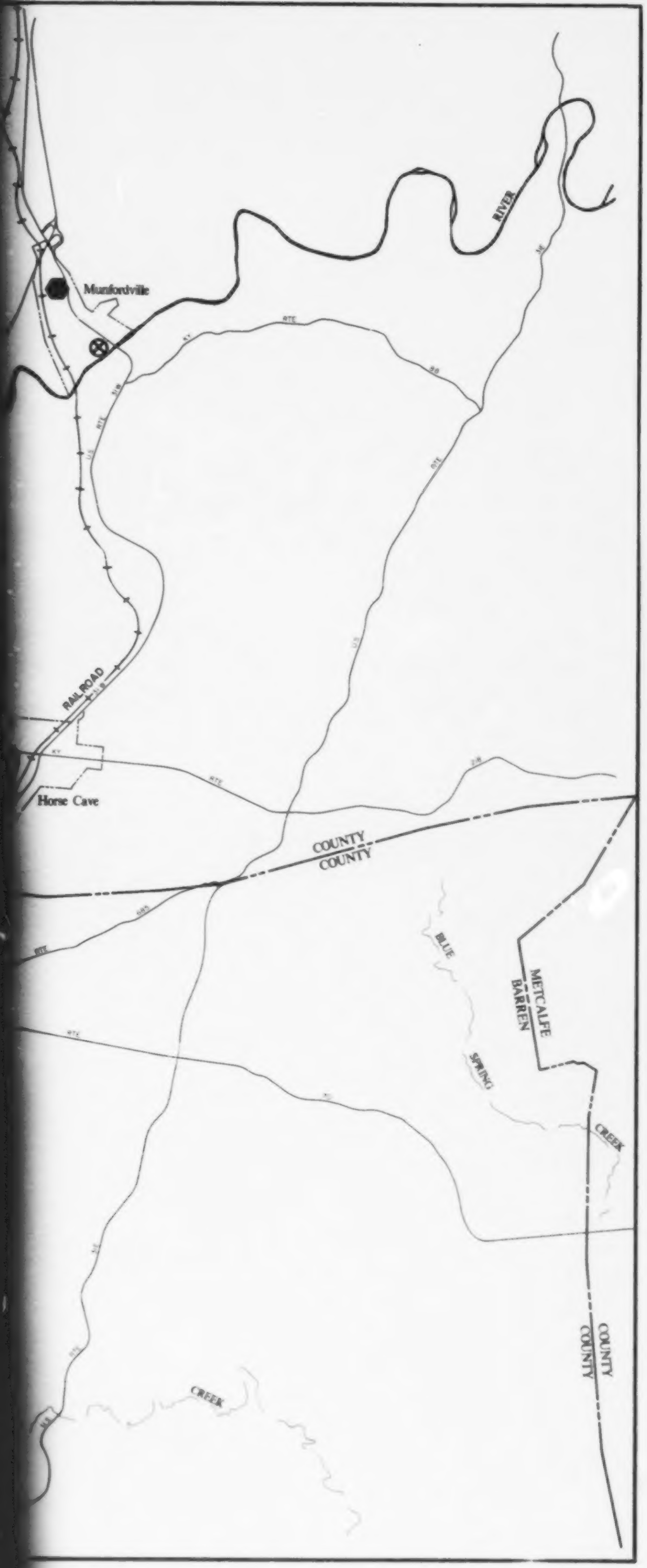
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COUNTY

LEGEND

▒ MAMMOTH CAVE NATIONAL PARK
— FORCE MAIN
---- GRAVITY INTERCEPTOR
⊗ EXISTING TREATMENT FACILITY
● UPGRADED EXISTING FACILITY
■ NEW WASTEWATER TREATMENT FACILITY
▲ PUMPING STATION
⬢ ON-LOT SYSTEMS
▨ LAND APPLICATION SITE

FIGURE III - 9

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

WASTEWATER MANAGEMENT
ALTERNATIVE 4

PC - 2 PLUS (SA - CC - HC) 3 PLUS MN - 1

12,000 6000 0 12,000 24,000
Scale In Feet

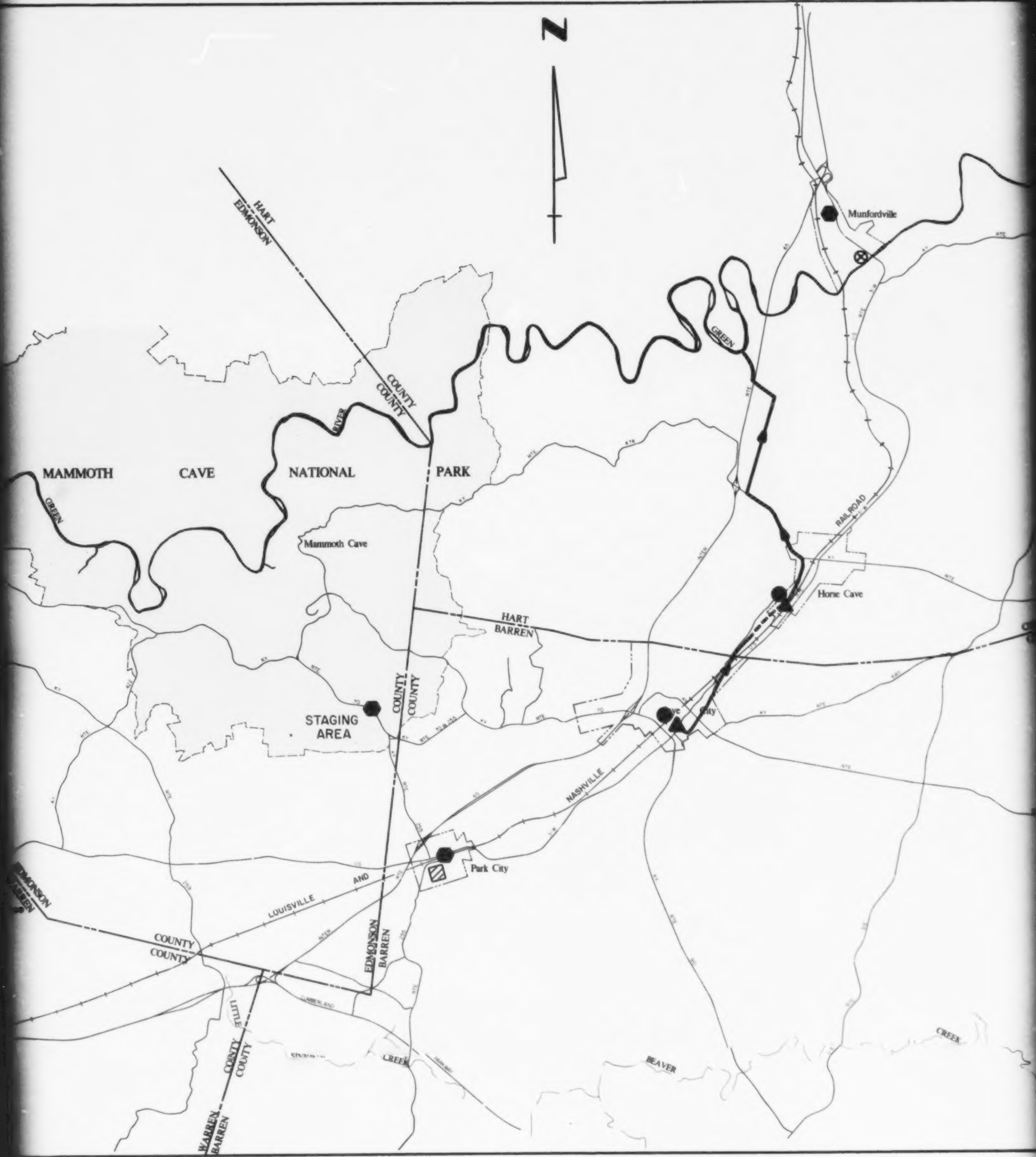
U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

WASTEWATER MANAGEMENT ALTERNATIVE 5

SA plus PC-2 plus (CC-HC) 8 plus MN-1

Major Components:

- Composting waterless toilets - septic tank/soil absorption system for greywater at the proposed Staging Area
- Conventional and alternate on-lot treatment systems at Park City
- Small community low pressure sewer system and community soil absorption field at Park City
- Upgraded (.37 mgd) existing Cave City treatment plant (Secondary treatment Class III reliability)
- Conveyance facilities to transport treated wastewater from Cave City plant to Horse Cave
- Upgraded (.53 mgd) existing Horse Cave treatment plant (Secondary treatment Class III reliability)
- Pump station and force main to convey treated wastewater to Green River discharge point
- Additional on-lot treatment systems at Munfordville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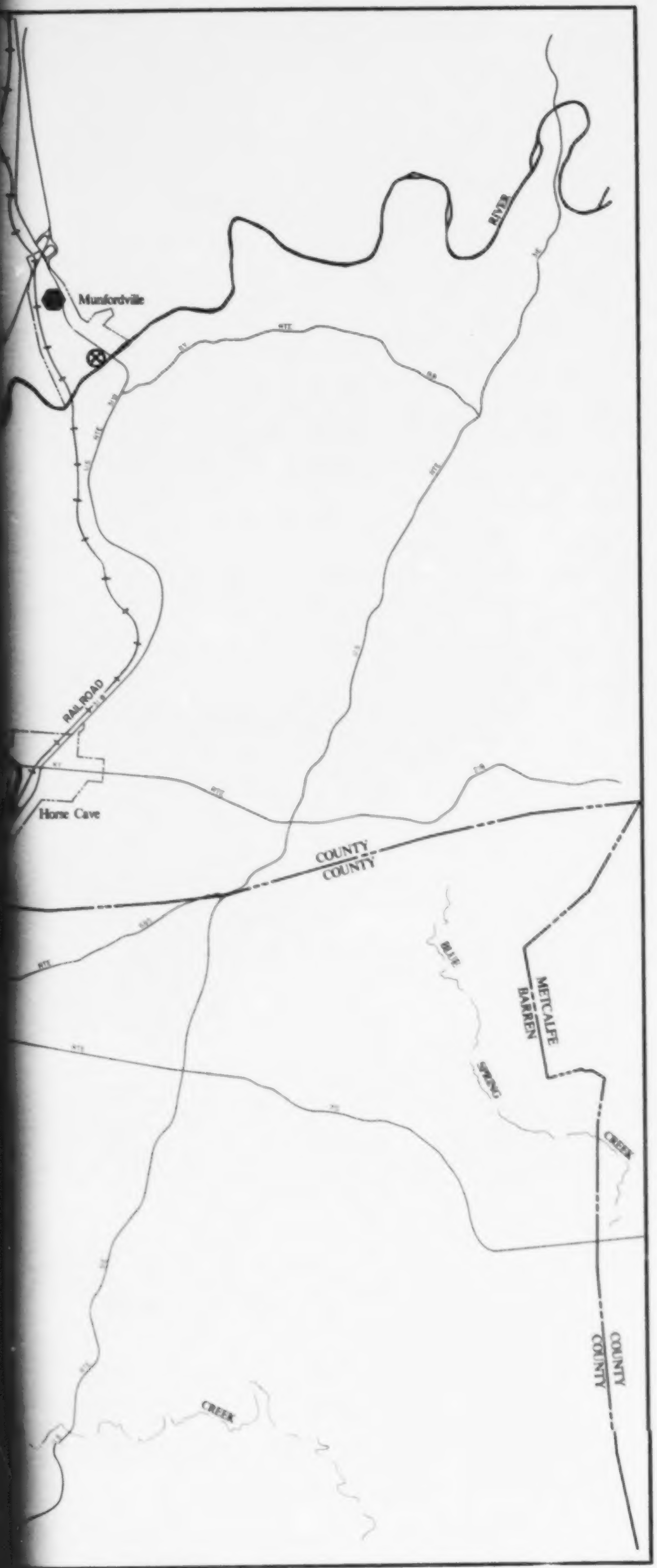

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METCALFE
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LEGEND

▭	MAMMOTH CAVE NATIONAL PARK
—	FORCE MAIN
----	GRAVITY INTERCEPTOR
⊗	EXISTING TREATMENT FACILITY
●	UPGRADED EXISTING FACILITY
▲	PUMPING STATION
⬢	ON-LOT SYSTEMS
▨	LAND APPLICATION SITE

FIGURE III - 10

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

WASTEWATER MANAGEMENT ALTERNATIVE 5

SA PLUS PC-2 PLUS (CC-HC)8 PLUS MN-1

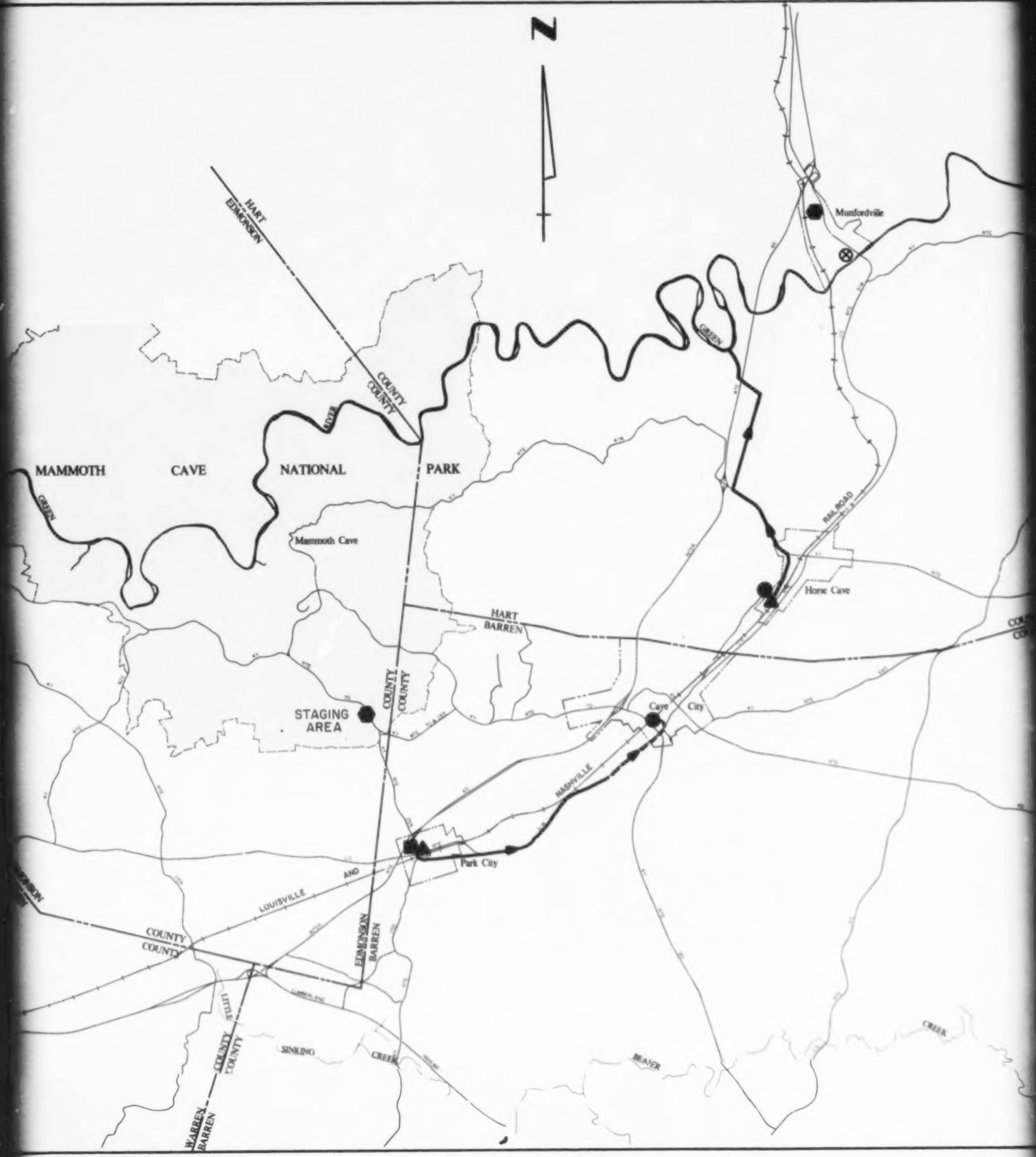
12,000 6000 0 12,000 24,000
Scale In Feet

U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

WASTEWATER MANAGEMENT ALTERNATIVE 6
5A plus (PC-CC) 2 plus HC-4 plus MN-1

Major Components:

- Composting waterless toilets - septic tank soil absorption system for greywater at the proposed Staging Area
- Wastewater collection system at Park City
- Extended aeration wastewater treatment facility (0.08 mgd) at Park City
- Conveyance facilities to transport treated wastewater to Cave City discharge point
- Upgraded (.37 mgd) existing wastewater treatment plant at Cave City (Advanced secondary treatment, Class I reliability)
- Subsurface discharge at Cave City
- Upgraded (.53 mgd) existing Horse Cave wastewater treatment facility (Secondary treatment, Class III reliability)
- Pumping station and force main to convey treated Horse Cave wastewater to the Green River discharge point
- Additional on-lot treatment systems at Munfordville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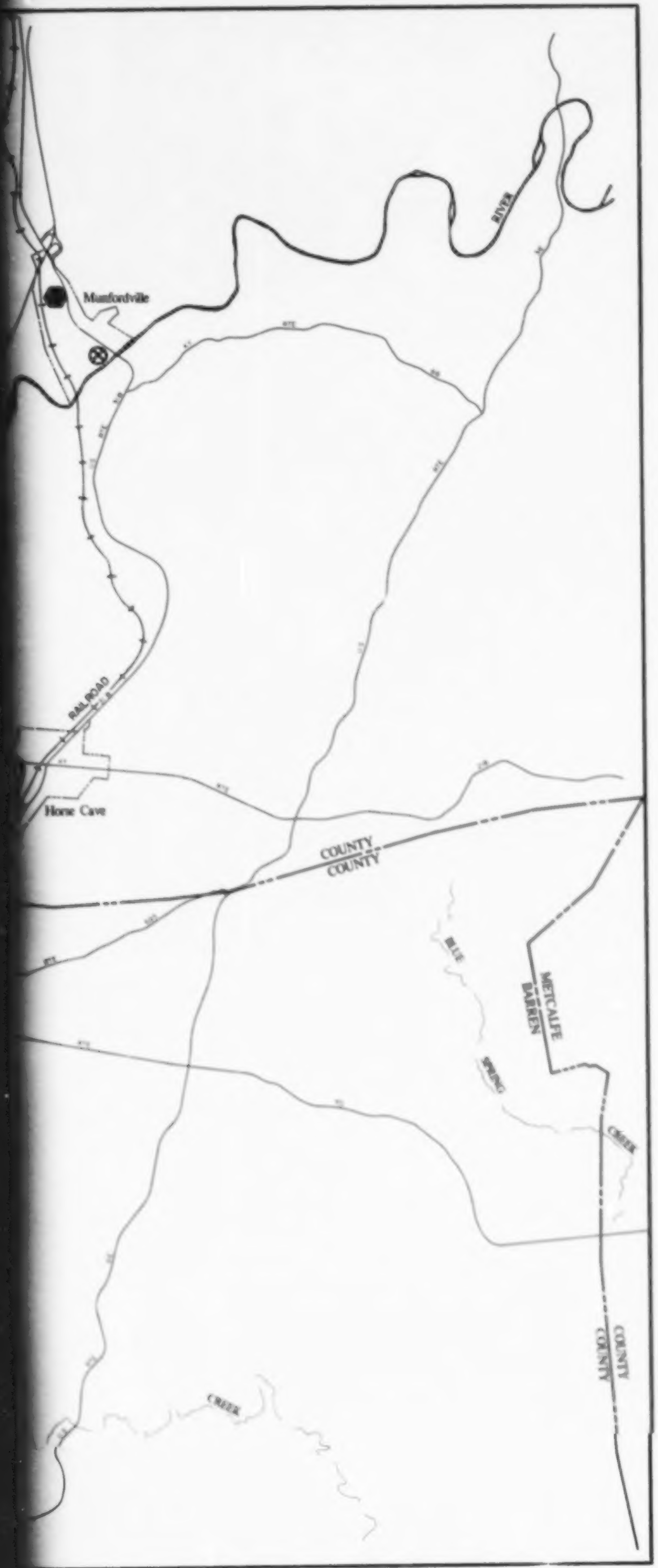
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LEGEND

▨ MAMMOTH CAVE NATIONAL PARK
— FORCE MAIN
---- GRAVITY INTERCEPTOR
⊗ EXISTING TREATMENT FACILITY
● UPGRADED EXISTING FACILITY
■ NEW WASTEWATER TREATMENT FACILITY
▲ PUMPING STATION
⬣ ON-LOT SYSTEMS

FIGURE III-11

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

WASTEWATER MANAGEMENT ALTERNATIVE 6

SA PLUS (PC-CC) 2 PLUS HC-4 PLUS MN-1

12,000 6000 0 12,000 24,000
Scale In Feet

U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

WASTEWATER MANAGEMENT ALTERNATIVE 7
PC-2 plus (SA-CC) plus HC-4 plus MN-1

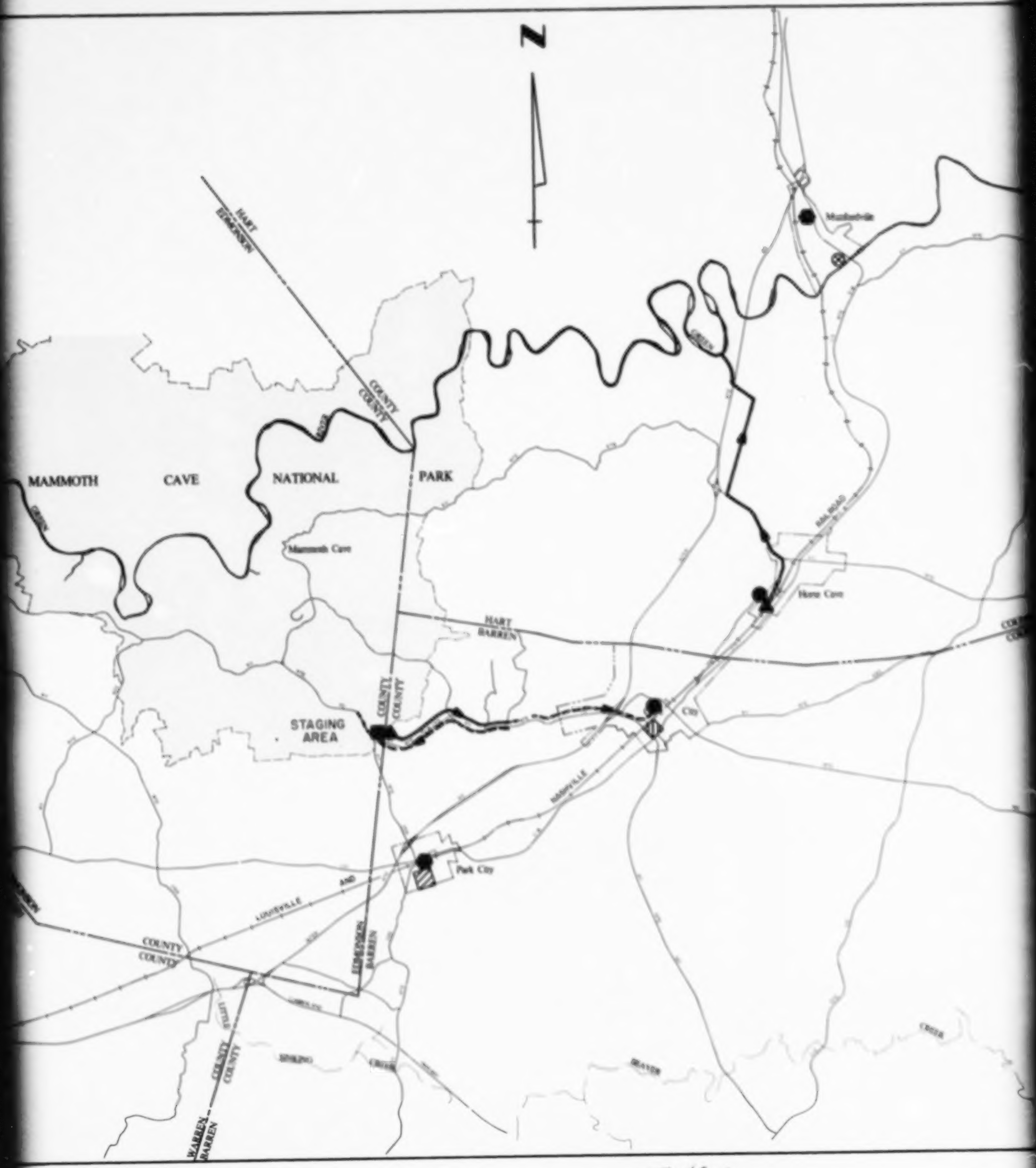
Major Components:

- Conventional and alternate on-lot systems at Park City
- Small community low pressure sewer system and community soil absorption field at Park City
- Gravity conveyance to transport raw wastewater from proposed Staging Area to Chaumont treatment site
- Gravity interceptor to convey wastewater from Rt. 70 development to the treatment facility at Chaumont
- Extended aeration wastewater treatment facility (0.105 mgd) at Chaumont from Staging Area and Rt. 70 wastewater
- Pump station and force main at Chaumont to convey treated wastewater to gravity interceptor for gravity flow to Cave City along Rt. 70
- Gravity interceptor to convey treated wastewater and additional raw wastewater to Cave City treatment facility
- Upgraded existing (0.45 mgd) Cave City wastewater treatment plant (Secondary treatment, Class III reliability)
- Spray irrigation land application system (Dry season operation)
- Subsurface discharge (wet season operation)
- Upgraded (.53 mgd) existing Horse Cave treatment wastewater treatment facility (Secondary treatment, Class III reliability)
- Pumping station and force main to convey treated Horse Cave wastewater to the Green River discharge point
- Additional on-lot treatment systems at Munfordville

WASTEWATER MANAGEMENT ALTERNATIVE 8
PC-2 plus SA plus CC-3 plus HC-4 plus MN-1

Major Components:

- Conventional and alternate on-lot systems at Park City
- Small community low pressure sewer system and community soil absorption field at Park City
- Composting waterless toilets - septic tank/soil absorption system for greywater at the proposed Staging Area
- Upgraded (.37 mgd) existing wastewater treatment plant at Cave City (Advanced Secondary treatment, Class I reliability)
- Subsurface discharge of Cave City effluent
- Upgraded (.53 mgd) existing Horse Cave wastewater treatment facility (Secondary treatment, Class III reliability)
- Pumping station and force main to convey treated Horse Cave wastewater to the Green River discharge point
- Additional on-lot treatment systems at Munfordville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Park City
LOUISVILLE
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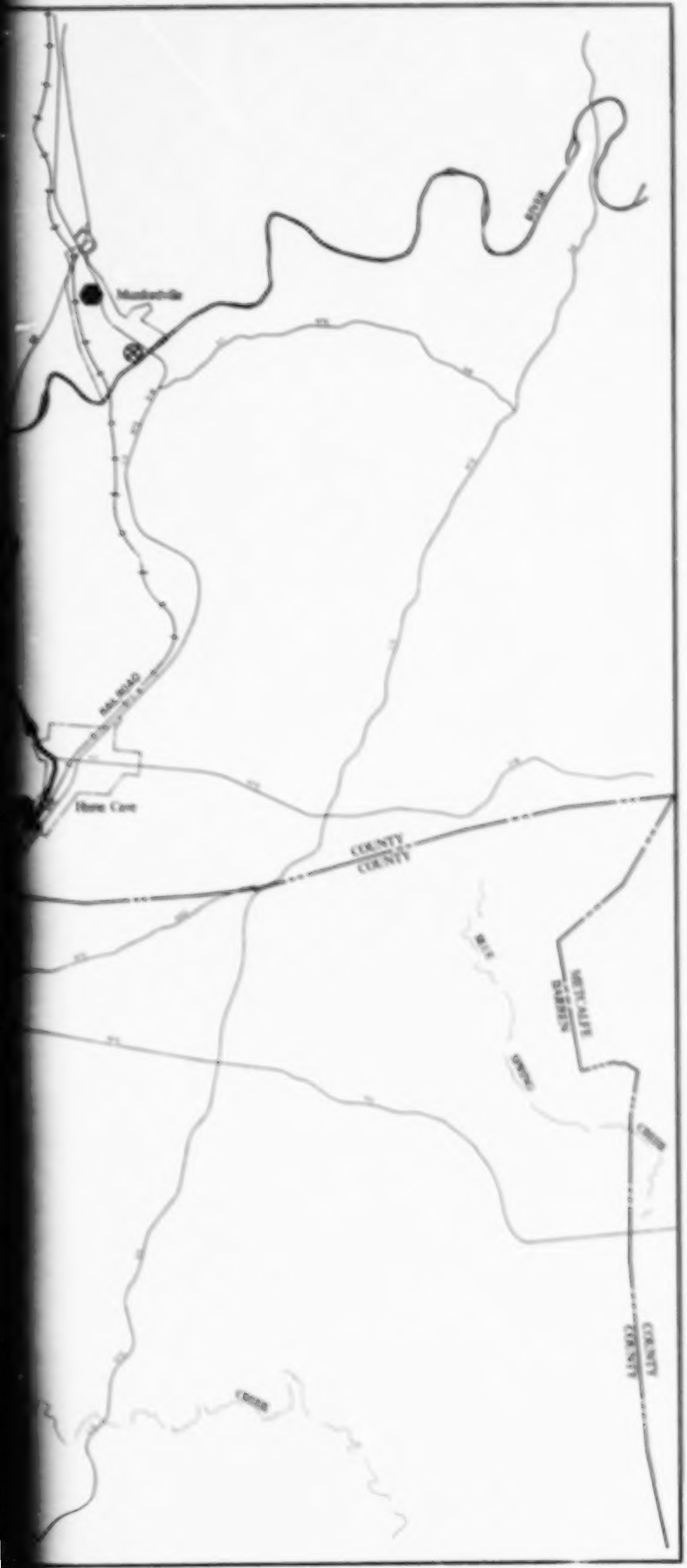
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METCALFE
BARREN
CREEK
COUNTY
COUNTY

LEGEND

▭ MAMMOTH CAVE NATIONAL PARK
—— FORCE MAIN
- - - - GRAVITY INTERCEPTOR
⊗ EXISTING TREATMENT FACILITY
● UPGRADED EXISTING FACILITY
■ NEW WASTEWATER TREATMENT FACILITY
▲ PUMPING STATION
⬢ ON-LOT SYSTEMS
▨ LAND APPLICATION SITE

FIGURE III - 12

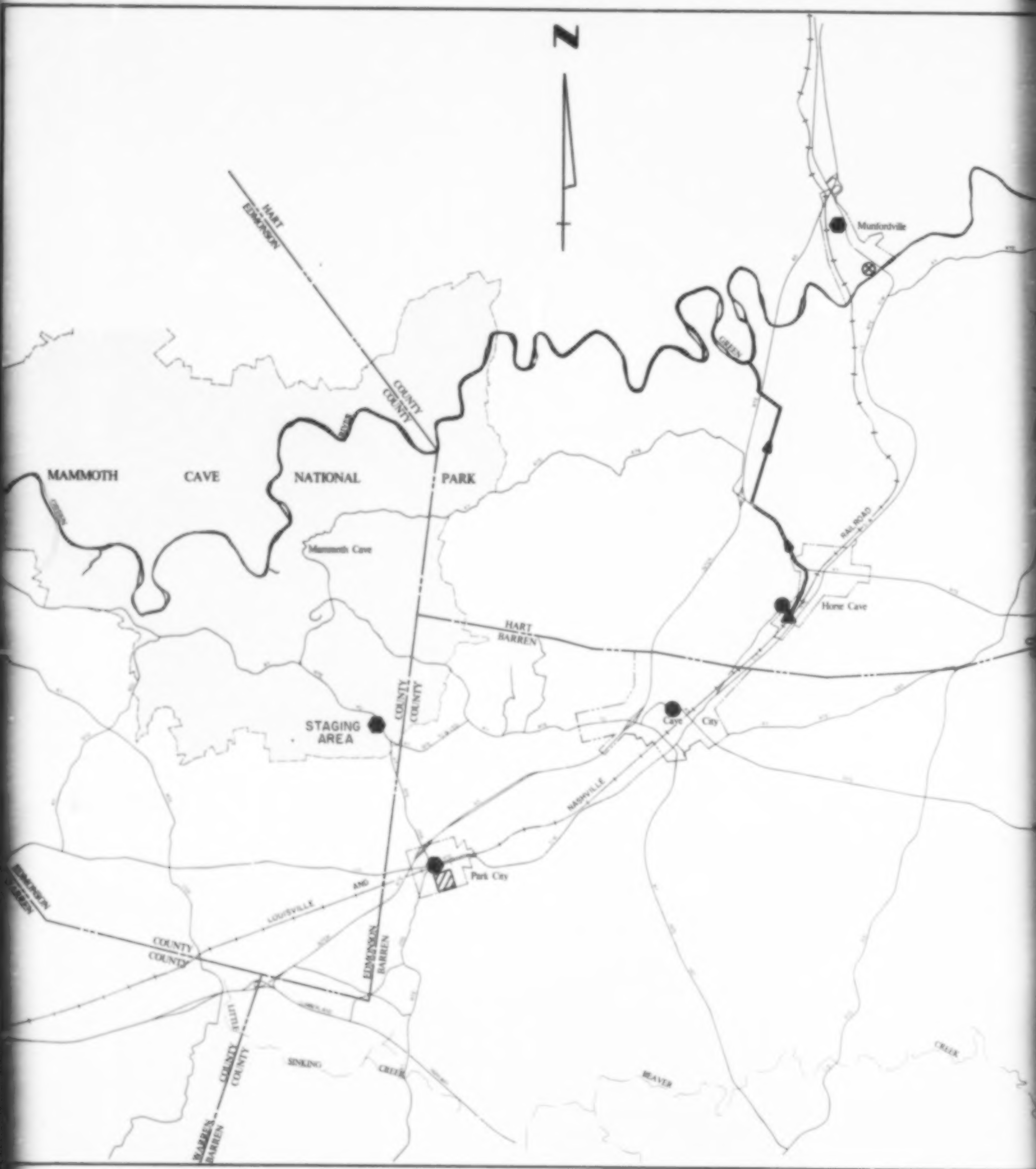
MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

WASTEWATER MANAGEMENT
ALTERNATIVE 7
PC-2 PLUS (SA-CC) PLUS HC-4 PLUS MN-1

12,000 6000 0 12,000 24,000
Scale In Feet

U.S. Environmental Protection Agency
Region IV Atlanta, Georgia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Horse Cave
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BARREN
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STAGING
AREA
Cave
City
NASHVILLE
Park City
EDMONSON
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LOUISVILLE
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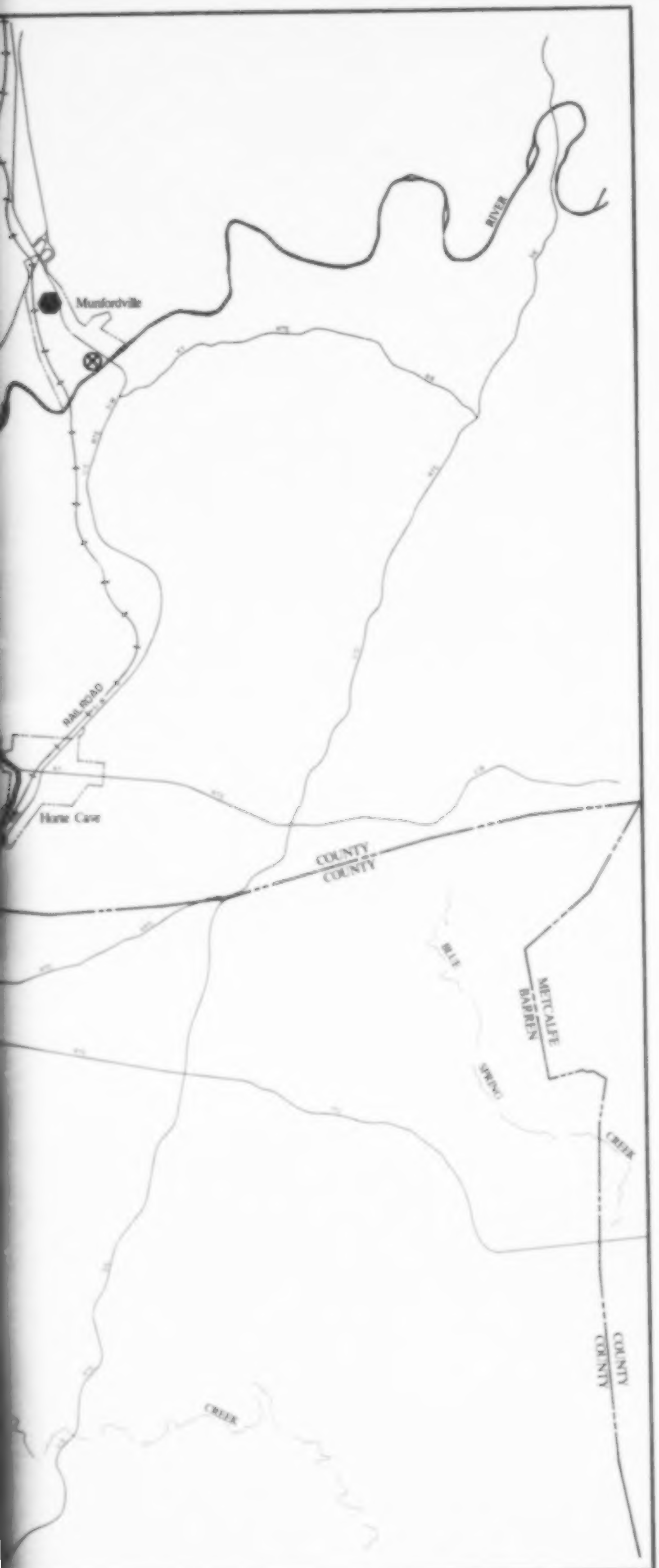
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Horse Cave
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METCALFE
BARREN
CREEK
COUNTY
COUNTY

LEGEND

▭	MAMMOTH CAVE NATIONAL PARK
——	FORCE MAIN
----	GRAVITY INTERCEPTOR
⊗	EXISTING TREATMENT FACILITY
●	UPGRADED EXISTING FACILITY
▲	PUMPING STATION
⬢	ON - LOT SYSTEMS
▨	LAND APPLICATION SITE

FIGURE III - 13

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

WASTEWATER MANAGEMENT
ALTERNATIVE 8

PC - 2 PLUS SA PLUS CC - 3
PLUS HC - 4 PLUS MN - I

12,000 6000 0 12,000 24,000
Scale In Feet

U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

2. COST EVALUATION

A detailed evaluation of all significant cost components of the alternative wastewater management systems is required in order to perform the comparative cost analysis. Construction, project, and operation and maintenance costs are developed for each management system for incorporation into a net present worth cost analysis. The present worth cost analysis establishes a basis for comparison of total costs (capital and annual operations costs) for each of the wastewater management alternatives. These total costs include the federal share of the costs associated with construction grants. Comparative cost analysis (either present worth or equivalent annual cost) is an EPA requirement in performing the cost effectiveness analysis and serves as the primary cost evaluation criterion according to EPA guidelines.

Cost Development

Construction, project, and operation and maintenance costs are developed for all wastewater facilities in each management system.* Available local cost data, data from recent similar projects, standard costing sources and detailed engineering estimates are used in cost development. All costs are trended to 1981 price levels projected for the Mammoth Cave area.

The major cost components of each wastewater management alternative are listed with Figures III-6 to III-13 and include wastewater collection, conveyance, treatment and disposal facilities. Cost estimates for these different wastewater facilities are obtained from various sources as described below.

> Wastewater treatment facilities: Construction, and operation and maintenance cost estimates for wastewater treatment facilities are obtained from unit process cost curves developed for small community systems by Henry H. Benjes, Jr. (Benjes, Henry H., "Small Community Wastewater Treatment Facilities - Biological Treatment Systems," EPA Technology Transfer Design Seminar Handout, Small Wastewater Treatment Facilities, January 1978).
>
> Pumping Station: Estimates for construction and operation of wastewater pumping stations are based on Benje's cost curves for package raw wastewater pumping stations since wastewater

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* Cost estimates for wastewater management are developed readily from detailed estimates prepared for the cost evaluation of local and joint wastewater treatment/disposal options. Since each of the wastewater management alternatives is composed of two or more recommended options, the estimated cost for any management alternative is the sum of the costs of wastewater facilities (collection, conveyance, treatment and disposal) associated with the recommended treatment/disposal options incorporated into that management alternative.

flows in the study area are relatively small.

Force mains, gravity sewers and interceptors: Construction cost estimates for force mains, and gravity collection and conveyance facilities are based on unit costs developed using the Davis Bacon labor rates for the Mammoth Cave area (December 1978), detailed engineering estimates and bid prices from recent similar projects. ($/linear foot unit price estimates confirmed with local contractor). Operation and maintenance costs are based on those developed for conveyance facilities in the U.S. Corps of Engineers' Metro Wheeling and Ohio Urban Study Wastewater Management Investigation (Draft report, March 1978).

Low pressure sewers: Costs for low pressure sewer systems are estimated using EPA Technology Transfer, *Alternatives for Small Wastewater Treatment Systems Pressure Sewers/Vacuum Sewers,* EPA-625/4-77-011 bid prices for a low pressure sewer construction project and cost estimates from similar projects.

Land application systems: Construction as well as operation and maintenance cost estimates for major components of spray irrigation systems are obtained primarily from EPA Technology Transfer, *Costs of Wastewater Treatment by Land Application,* EPA-430/9-75-003, 1976.

Conventional and alternate on-lot systems: Cost estimates for on-lot system are based on costing information developed for the Comprehensive Water Quality and Management Plan (COWAMP) for Pennsylvania Central and Lower Susquehanna River Basin.

Project costs for the construction of new wastewater facilities (except individual on-lot systems) include construction costs plus costs for related project overhead, such as engineering design and construction inspection, legal and administrative work, financing, and general contingencies. Overhead is estimated to be 30 percent of construction costs.

Factors that are considered in estimating operation and maintenance costs include labor and power requirements and material costs. Assumed rates for labor costs and power are $7/man-hour and 4 cents/kwh respectively. Operation and maintenance costs for wastewater treatment plants are estimated based on design capacity and assumed to be constant through the planning period. This is because the fixed costs associated with the operation of treatment works are considered more significant, and therefore, the adjustment of flow-related costs to an average rate during the planning period doesn't appear to significantly change the estimated overall operation costs. Pumping station operation and maintenance costs, however, are significantly effected by flow since the greatest costs are due to power consumption. These cost estimates are based on annual average flows for 1990 (planning period mid-point) and are considered to be constant for the entire planning period. With the exception of pumping costs which are based on 1990 average flow, operation and maintenance costs for spray irrigation are based on design capacity. For seasonal spray irrigation, labor costs associated with transmission and distribution are assumed to be about two-thirds the estimated annual rate. On-lot and low pressure sewer system operation and maintenance are based on the number of units estimated to be in operation during the planning period.

Present Worth Analysis

As previously noted, the alternative wastewater management systems are to be compared on the basis of their relative net present worth in accordance with EPA regulations. The present worth analysis establishes an estimated total cost value of the capital expenditures (project costs) and operating costs of each alternative over the duration of the planning period. For the purposes of this net present worth evaluation, construction of the wastewater facilities in the wastewater management alternatives is assumed to take place in 1983, resulting in a 17-year planning period ending with the year 2000. The discount rate used in the net present worth analysis is 7.125 percent. In accordance with EPA guidelines, allowances are made for salvage value at the end of the planning period. Also, phasing of construction is included in the analysis where applicable.

The present worth analysis of the eight wastewater management alternatives is presented in Table III-5. Based on net present worth, Alternative 8 (local treatment at each of the five population centers) is the least costly at 7.6 million. However, Alternative 5 (SA plus PC-2 plus (CC-HC) plus MN-1) provides for removing both Cave City and Horse Cave discharges from the subsurface with a net present worth increase of approximately $0.35 million. Another consideration is providing wastewater services to the Rt. 70 area. The least costly alternative involving service to this area is Alternative 7. This, however, represents a net present worth increase of approximately $2.1 million over Alternative 8 even accounting for 15% cost preference for (SA-CC) spray irrigation and pre-treatment facilities.

3. ENVIRONMENTAL EVALUATION

The current status of the environmental conditions (natural and man-made) in the Mammoth Cave area is described in the Environmental Inventory Task Report. The environmental evaluation process uses this inventory as a baseline against which impacts can be assessed. The evaluation format and parameters used in the environmental evaluation process are organized to parallel the environmental inventory, thus facilitating comparison between inventory and impacts evaluation documents.

In order to incorporate environmental impacts evaluation into a cost-effectiveness analysis or to compare relative impacts of one wastewater management alternative with another, it is necessary to quantify or assign a numerical value to this subjective evaluation. This section deals with the development of numerical environment

TABLE III-5
PRESENT WORTH ANALYSIS
UPDATE

Wastewater Management Alternative	1981 Project Cost	Annual O&M Costs	Present Worth Annual O&M Costs	Total Present Worth	Year 2000 Salvage Value	Present Worth Salvage Value	Net Present Worth	Cost Ranking
Alternative 1 (SA-PC-CC-HC)^2 plus MN-1	9,985,000	233,000	2,255,000	12,240,000	4,494,000	1,395,000	10,845,000	7
Alternative 2 (PC-SA-CC-HC)^2 plus MN-1	10,574,000	261,000	2,527,000	13,101,000	4,770,000	1,481,000	11,620,000	8
Alternative 3 SA plus (PC-CC-HC)^3, plus MN-1	8,804,000	237,000	2,294,000	11,098,000	4,007,000	1,244,000	9,854,000	5
Alternative 4 PC-2 plus (SA-CC-HC)^3 plus MN-1	9,030,000	252,000	2,439,000	11,469,000	3,626,000	1,126,000	10,343,000	6
Alternative 5 SA plus PC-2 plus (CC-HC)^8 plus MN-1	6,546,000	230,000	2,226,000	8,772,000	2,568,000	797,000	7,975,000	2
Alternative 6 SA plus (PC-CC)^2 HC-4 plus MN-1 plus filters**	7,834,000	235,000	2,275,000	10,109,000	3,467,000	1,076,000	9,033,000	
	338,000	22,000	213,000	551,000	9,400	29,000	522,000	3
	8,172,000	257,000	2,488,000	10,660,000	3,561,000	1,105,000	9,555,000	
Alternative 7 PC-2 plus (SA-CC) plus HC-4 plus MN-1	8,675,000	252,000	2,439,000	11,114,000	3,412,000	1,059,000	* 9,704,000	4

TABLE III-5 (Cont'd.)

Wastewater Management Alternative	1981 Project Cost	Annual O&M Costs	Present Worth Annual O&M Costs	Total Present Worth	Year 2000 Salvage Value	Present Worth Salvage Value	Net Present Worth	Cost Ranking
Alternative 8 SA plus PC-2 plus CC-3 plus HC-4 plus MN-1	5,576,000	228,000	2,207,000	7,783,000	2,031,000	630,000	7,153,000	1
plus filters**	300,000	21,000	203,000	503,000	84,000	26,000	477,000	
	5,876,000	249,000	2,410,000	8,286,000	2,125,000	656,000	7,630,000	

* This net present worth is adjusted for 15% cost preference for (SA-CC) spray irrigation and pretreatment facilities.

** Filters are only considered for Cave City

Note: All costs have been developed to accommodate flows from Park City and National Park Service Staging Area.

impacts ratings for both the natural and man-made environment and includes a description of the evaluation methodology, a numerical ranking of the eight wastewater management alternatives with respect to natural and man-made environment impacts, and a disucssion of the impacts ratings for each of the alternatives.

Natural Environment

As previously discussed, a natural environmental impacts evaluation is included as part of the process for local and joint wastewater treatment/disposal options to be incorporated into the wastewater management alternatives. (The results of those evaluations are presented in Appendix III). Because the impacts rating developed for any local or joint treatment option is not an absolute rating but a relative score for comparison in selecting the particular, option, the individual impacts ratings for the options incorporated into a wastewater management alternative cannot be added like costs to obtain an environmental impacts rating for the management alternative. An evaluation of the "total system" with respect to impacts on the natural environment is required, therefore, for each of the wastewater management alternatives. The evaluation process and parameters evaluated, however, are identical to those used in the environmental evaluation of local and joint treatment/disposal options as described below.

Evaluation Process

A parameter-checklist evaluation methodology is used for the evaluation of impacts to the natural environment for both the local and joint treatment disposal options, and the eight wastewater management alternatives. This methodology presents a specific list of environmental parameters to be investigated for possible impacts but does not require the establishment of direct cause-effect links to project activities. The list of parameters to be investigated is based on the Environmental Inventory prepared for the project, with special emphasis on those resources that have been identified as sensitive. Parameter checklists can be subdivided into four categories: simple, descriptive, scaling and scaling-weighting. A simple checklist lists parameters which are affected by specific activities. No guidelines are established for the measurement and interpretation of data. Descriptive checklists include both a parameters list and a guide for impact measurement. The simple and descriptive checklist methodologies are primarily used in the initial phases of a project and to initiate alternative evaluation procedures.

Scaling checklists have the added component of subjective scaling of the relative magnitude of impacts. Scaling-weighting checklists contain an additional weighting factor for a subjective evaluation of the relative importance of the impact. Two examples of scaling-weighting checklist methods are the Environmental Evaluation System (Dee, Baker, Drobny & Duke, 1973) and the Optimum Pathway Method (Odum, et al., 1971). Scaling and scaling-weighting checklists have been widely used and are a valuable tool in alternative evaluation.

A scaling-weighting checklist is used in this project for the evaluation of potential impacts to the natural environment. Parameters are selected to conform with the subdivision of the Environmental Inventory Task Report. Weights are assigned to the parameters by an interdisciplinary team of biologist, planners, and engineers. Scaling is accomplished by assigning rates for each parameter relative to the magnitude of the impact for each option. Both weights and rates have a range of zero to four according to the following scheme:

0 = no importance/impact
1 = slight importance/impact
2 = moderate importance/impact
3 = significant importance/impact
4 = highly significant importance/impact

Rates (impacts) may be either beneficial (+) or adverse (-). The score for a parameter-wastewater management alternative combination is the product of the weight and the rate:

$$(\text{Score})_{P-A} = (\text{Weight})_{P} \ \text{X} \ (\text{Rate})_{P-A}$$

The score for any given parameter-alternative combination can range from a (-) 16 for a highly significant adverse impact on a parameter with a highly significant importance to a (+) 16 for a highly significant beneficial impact on a similar parameter. The summation of the scores for an individual alternative yields a cummulative comparative score for that alternative.

Parameters and Weights

As stated, evaluation parameters are selected to coincide with the environmental inventory and to emphasize sensitive resources. The conformity with the inventory/format insures the inclusion of all significant issues and facilities the direct comparison of inventory and evaluation task reports. The emphasis on sensitive resources is accomplished through the inclusion of the "Sensitive Areas" parameter and the assignment of weights.

Weights are assigned to reflect the relative importance of the parameters in the study area. The weighting process was executed by an interdisciplinary team. Each team member was involved in the previous project activities and had an understanding of the issues and environmental conditions within the study area. Each parameter-weight combination is described below as to its content and significance and is summarized in Table III-6.

Groundwater Quality (free-flowing and diffuse): The current qualtiy of groundwater is documented in the Environmental Inventory and Supplemental Report. With few exceptions the groundwater quality is consid-

TABLE III-6

NATURAL ENVIRONMENTAL EVALUATION PARAMETERS AND WEIGHTS FOR THE MAMMOTH CAVE AREA EIS

PARAMETER	WEIGHT	MAJOR IMPACT SOURCES
Groundwater Quality:		
Free Flowing	4	Municipal wastes, industrial wastes, septic tanks, agricultural runoff, urban runoff, landfills, pipeline leakage, construction
Diffuse	3	
Groundwater Quantity:		
Free Flowing	1	Land use changes, effluent disposal, construction, urban runoff
Diffuse	1	
Groundwater Supplies	3	Municipal wastes, industrial wastes, landfills, pipeline leakage, agricultural runoff
Surface Water:		
Quality	3	Municipal wastes, industrial wastes, agricultural runoff, deforistation, urban runoff, siltation, dam construction, channelization
Quantity	1	
Biology	3	
Terrestrial Vegetation	2	Project construction - treatment facilities & pipelines, Secondary growth and land use changes
Wildlife	2	Destruction of habitat associated with project construction and land use changes
Cave Biological Systems	4	Municipal wastes, industrial wastes, septic tanks, agricultural runoff, urban runoff, landfills, pipeline leakage, surface construction, water projects, siltation
Rare & Endangered Species	4	Habitat destruction, construction. land use changes
Sensitive Areas	4	Habitat destruction, construction, land use changes
Soils	2	Construction activities, erosion, land use changes
Geology	2	Construction activities, facilities, and pipelines
Topography	1	Construction activities, facilities, and pipelines
Air Quality	1	Facility construction and operation, secondary growth
Noise	1	Facility construction and operation, secondary growth
Odor	1	Facility malfunction

ered to be excellent. Areas with extreme groundwater problems are associated with either wastewater treatment plant effluent discharge points (Hidden River Cave) or with oil well sites (Parkers Cave-Sulfur River). The groundwater quality problem at Hidden River Cave is one of the primary reasons for this environmental impact statement. Because of the magnitude of the current problem and its direct association with current waste treatment methods, the free-flowing groundwater quality parameters are assigned a weight of "4" - highly significant. The diffuse component of ground water quality is assigned a weight of "3" - significant. While a large section of the sample area utilizes Rio Springs as a water supply, many households use private wells. These wells primarily tap the diffuse groundwater component. Groundwater quality can be affected by a large number of activities. The most obvious influence on groundwater quality in the study area is the discharge of treatment facility effluent. Additional impacts are associated with septic tank absorption fields, direct discharge of wastewaters, land treatment and disposal, and pipeline leaks. Activities not directly related to the treatment methods also influence water quality. These include construction activity, urban runoff and agriculture/silviculture activities.

Groundwater Quantity (free-flowing and diffuse): The Karst nature of the study area produces a marked dominance of groundwater drainage over surface water drainage. The Environmental Inventory documents a wide variation in free-flowing groundwater quantity in response to rainfall events. Studies have also documented variation in travel times and drainage patterns. In view of the dominant subsurface drainage, the importance of the groundwater quantity parameter in the option analysis is minimal. The parameter has therefore been assigned the weight of "1" - slight. Impacts to groundwater quantity are both direct and indirect. Direct impacts can be associated with the types of treatment and disposal option (land application - vs. - point discharge - vs. - septic field). Indirect impacts are usually associated with changes in land use and in particular with increases in urbanization and urban runoff.

Groundwater Supplies: As mentioned above, groundwater is currently used in parts of the study area as the primary drinking water source. While many areas do not use the groundwater supply, this resource is extremely valuable. Activities which may restrict the use of the groundwater supply must be carefully considered. This is particularly true of wastewater facility planning which, while not generally producing irreversible effects, can have longterm effects on treatment and disposal methods and future growth patterns in the area. Groundwater supplies are assigned a weight of "3" - significant, in light of the potential use of this resource, especially with respect to waters in the Hidden River Cave complex.

Surface Water Quality - Quantity - Biology: The major surface water feature in the study area is the Green River. Chemical and biological investigations of this river indicate that it is of high quality (Environmental Inventory Task Report). The operation of the Munfordville Treatment Facility appears to have only minor, if any, effects on the river quality and biology. The river is currently impounded from Lock No. 6 near Brownsville through most of Mammoth Cave National Park. The U.S. Army Corps of Engineers is currently considering the removal

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of Lock No. 6. The Green River is currently used to a moderate degree for recreation in the forms of boating and fishing. The current condition of the Green River, high water quality-healthy biological communities, makes it a resource of significant value. The parameters of surface water quality and surface water biology are therefore assigned a weight of "3" - significant. However, surface water quantity is assessed as being of slight importance (1). The regulated nature and large size of the Green River reduce the importance of the relatively small potential wastewater inputs from the Mammoth Cave area.

Terrestrial Vegetation: The natural vegetation in the study area has been greatly modified. The clear cutting of forests and subsequent farming of suitable areas has determined the current pattern of floral distributions. The degree of agricultural modification is associated with the severity of the local topography. Relatively flat areas have been clearcut while areas with steep slopes have been selectively cut. In light of the past modifications to the floral community, the remaining vegetation constitutes a significant resource. However, it is considered of moderate importance with respect to this environmental impact study. This is reflected in the assignment of a weighting factor of "2" to the terrestrial vegetation parameter. The current patterns of vegetation cover in the area indicate that direct impacts from project construction will not be great. Pipelines, if recommended, would generally be routed along highway right-of-ways. Treatment facilities and land treatment sites would probably be sited on agricultural land. The association between the less disturbed plant communities and steeper slopes reduces the likelihood of major impacts to the terrestrial vegetation.

Wildlife: The complex plant communities of the study area and the protection afforded by Mammoth Cave National Park support a diverse animal community. Wildlife is primarily impacted by the same activities which affect the terrestrial vegetation, primarily project-orientated construction (pipelines and treatment facilities) and increased development. Wildlife, though considered a significant resource, is considered only of moderate importance with respect to this particular environmental impact statement, and therefore, the wildlife parameter is assigneda weight of "2".

Cave Biological Systems: The cave systems of the Mammoth Cave area are some of the most extensively studies cave systems in the world. When compared with other cave systems, the biota of the Mammoth Cave/Flint Ridge system is extremely diverse. Cave system vulnerability to pollution, the interactions of various disturbances on cave communities and the impacts associated with various actions are discussed in the Environmental Inventory Task Report. The cave biota constitutes a highly significant resource and is assigned a weight of "4". Specific impacts to cave systems are summarized in Table I-18 of the Environmental Inventory Technical Reference Document and include impacts from municipal wastes, industrial wastes, septic tanks, agricultural runoff, urban runoff, pipeline leakage and surface construction.

Rare and Endangered Species: The rare and endangered flora and fauna in the study area is currently protected by federal regulations only. State protection has been removed by legislative action. The rare and endangered species of the study are listed in the Environmental Inventory Technical Reference Document. These species include mammals, birds, amphibians, reptiles, fish, invertebrates and plants. The protected status of these organisms requires that the parameter be assigned a weight of "4" - highly significant.

Sensitive Areas: The category of sensitive areas is used to emphasize those communities or areas which are not adequately included under the other parameters. These areas may include physically distinct areas such as marshes or swamps or they may represent communities or individuals which are not legally considered rare or endangered but are of significance (i.e., cave blindfish and the Mammoth Cave shrimp). The sensitive areas parameter is assigned a weight of "4" - highly significant.

Soils: Soils can be impacted through project related construction, changes in land use patterns and, to some extent, by land disposal or treatment options. Effects on soils generally include erosion which can also have large impacts on cave and surface water biological systems. The soil parameter is considered to be of moderate importance and is assigned a weight of "2".

Geology: The impacts to geology are usually minor for waste treatment projects. However, the karstic nature of the study area represents a relatively complex geologic setting which is described in the Environmental Inventory Technical Reference Document. Moderate geologic impacts may be associated with several of the options involving extensive pipeline or facility construction. Therefore, the parameter is assigned a weight of "2".

Topography: As for geology, topographic impacts for waste treatment projects are usually minor. Pipelines, if proposed, would likely follow existing roadways. Treatment facilities and land treatment sites would probably be sites on agricultural land with, at most, rolling topography. Topographic impacts are considered to be of slight importance for the treatment and disposal options and the parameter is assigned a weight of "1".

Air Quality: Generally, long term direct impacts to air quality can be caused by increased vehicular traffic associated with plant maintenance and operation and by sludge incineration among other factors. In addition, short term direct impacts are associated with the construction of new facilities. Long term indirect impacts to air quality can also be caused by increased vehicular traffic associated with increased secondary growth of the local population. However, air quality impacts associated with proposed wastewater management systems for the Mammoth Cave area are considered to be of relatively minor importance and are assigned a weight of "1".

Noise: Noise impacts are generally direct in nature. Short term direct impacts are associated with facility and pipeline construction. Long term direct impacts can be caused by facility operation. Noise impacts are only of slight importance for the project alternatives and are assigned the weight of "1".

Odor: There are currently major odor problems in the Horse Cave area. These problems are associated with the malfunctioning of the Horse Cave wastewater treatment plant. An assumption of this analysis is that for all alternatives considered except the "no-action" alternative, the Horse Cave facility will be upgraded to at least provide secondary treatment. This action is expected to greatly reduce the odor problem. Additional odor problems reported in the Park City area have been linked to faulty septic systems. Based on the assumption that the Horse Cave odor problem will be alleviated by improved treatment and because odor problems are limited to only a few sites in the study area, the parameter is considered to be of minor importance and is assigned a weight of "1".

Wastewater Management Alternatives Impacts Evaluation

Results of the natural environment impacts evaluation for the eight wastewater management alternatives are presented in Table III-7. This table provides the evaluation score for each alternative as well as its ranking with respect to anticipated impacts on the natural environment. In addition, Table III-8 provides the breakdown of the evaluation scores by parameter. The results of the evaluation are discussed below.

Wastewater Management Alternative - The first wastewater management alternative has a total environmental evaluation score of 60 points and an environmental ranking of third. Under WMA-1 wastewater from the Staging Area is transported to Park City where the combined flow is treated. This effluent is then pumped to Cave City, combined with the effluent from the Cave City facility, pumped to Horse Cave, combined with the Horse Cave effluent and then pumped to the Green River. WMA-1 also calls for additional on-lot treatment systems at Munfordville. Highly significant, beneficial impacts are predicted for free flowing groundwater quality, groundwater supplies, rare and endangered species and odor. The removal of current discharges from the area with final disposal to the Green River accounts for these ratings.

The moderate to slight negative impacts to groundwater quantity are assessed due to the change in disposal options and discharge point. The Green River discharge also accounts for the minor negative impacts to surface water quality and biology and the minor beneficial impact to surface water quantity. The extensive pipeline construction accounts for the moderate negative impacts on terrestrial vegetation and soils and the minor negative impacts to wildlife, topography, air quality and noise. The higher levels of treatment and reliability and the Green River discharge in WMA-1 should produce a highly significant, beneficial impact in the area of odor. The rates for the cave biological systems, rare and endangered species and "sensitive areas" parameters represent highly significant beneficial impacts. These ratings include several considerations including the degree of treatment wastewater receives before conveyance, the service areas included in the WMA, and discharge point. In WMA-1 all wastes, with the exception of those from the Staging Area receive secondary treatment prior to piping. This treatment reduces the impacts associated with pipeline leakage. The service areas include the Staging Area,

TABLE III-7

WASTEWATER MANAGEMENT ALTERNATIVES (WMA) NATURAL ENVIRONMENTAL IMPACTS RESULTS: RANKING

WMA NUMBER	WMA DESIGNATION	EVALUATION SCORE	ENVIRONMENTAL RANKING
1	(SA-PC-CC-HC) 2, MN-1	60	3
2	(PC-SA-CC-HC) 2, MN-1	71	1
3	SA-1, (PC-CC-HC) 3, MN-1	60	3
4	PC-2, (SA-CC-HC) 3, MN-1	63	2
5	SA-1, PC-2, (CC-HC) 8, MN-1	59	5
6	SA-1, (PC-CC), HC-4, MN-1	46	7
7	PC-2, (SA-CC) 1, HC-4, MN-1	57	6
8	PC-1, SA-1, CC-1, HC-4, MN-1	40	8

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TABLE III-8

NATURAL ENVIRONMENTAL IMPACTS EVALUATION SCORING

WASTEWATER MANAGEMENT ALTERNATIVES

Parameter	Weight	1		2		3		4		5		6		7		8	
		(SA-PC-CC-NC)2 MB-1		(PC-SA-CC-NC)2 MB-1		SA-1 (PC-CC-NC)3 MB-1		PC-2 (SA-CC-NC)3 MB-1		SA-1, PC-2 (CC-NC)8 MB-1		SA-1 (PC-CC)2, NC-4 MB-1		PC-2 (SA-CC)3 NC-4, MB-1		PC-1, SA-1, CC-1, NC-4, MB-1	
		Rate	Score	Rate	Score	Rate	Score	Rate	Score	Rate	Score	Rate	Score	Rate	Score	Rate	Score
Groundwater Quality:																	
Free flowing	4	4	16	4	16	4	16	4	16	4	16	2	8	3	12	2	8
Diffuse	3	3	9	4	12	3	9	3	9	3	9	4	12	3	9	2	6
Groundwater Quantity:																	
Free flowing	1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-1	-1	-1	-1	-1	-1
Diffuse	1	-1	-1	-1	-1	-1	-1	1	1	1	1	-1	-1	1	1	1	1
Groundwater Supplies	3	4	12	4	12	4	12	3	9	3	9	3	9	3	9	2	6
Surface water																	
Quality	3	-1	-3	-1	-3	-1	-3	-1	-3	-1	-3	-1	-3	-1	-3	-1	-3
Quantity	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Biology	3	-1	-3	-1	-3	-1	-3	-1	-3	-1	-3	0	0	0	0	0	0
Terrestrial Vegetation	2	-2	-4	-2	-4	-2	-4	-2	-4	-1	-2	-1	-2	-1	-2	-1	-2
Wildlife	2	-1	-2	-1	-2	-1	-2	-1	-2	-1	-2	-1	-2	-1	-2	0	0
Cave Biological Systems	4	3	12	4	16	3	12	3	12	3	12	2	8	3	12	2	8
Rare & Endangered Species	4	4	16	4	16	4	16	4	16	3	12	3	12	3	12	2	8
Sensitive Areas	4	3	12	4	16	3	12	4	16	3	12	2	8	3	12	2	8
Soils	2	-2	-4	-2	-4	-2	-4	-2	-4	-1	-2	-2	-4	-2	-4	-1	-2
Geology	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Topography	1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	0
Air Quality	1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
Noise	1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
Odor	1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
TOTAL			60		71		60		63		59		45		57		60

Park City, Cave City and Horse Cave but do not include the development along Rt. 70. Under WMA-1, the subsurface effluent discharges in the area are to be discontinued, resulting in beneficial impacts on groundwater quality, cave systems, "sensitive areas" and rare and endangered species.

Wastewater Management Alternative 2 - WMA-2 is very similar to WMA-1 in treatment options, disposal options, and environmental evaluation. The differences in system design include the pumping of effluent from Park City to the Staging Area and then to Cave City - Horse Cave - Green River, the construction of a gravity interceptor for the Rt. 70 development (east of Toohey Ridge to Cave City, west of Touhey Ridge to Chaumont), and a treatment facility near Chaumont. These changes provide a high degree of treatment prior to effluent transport and further protection from wastewater discharge to cave systems and "sensitive areas" by including existing development along Rt. 70.

The increased degree of protection is reflected in the highly significant, beneficial ratings for the "sensitive areas" and cave biological systems parameters. WMA-2 has a total environmental evaluation score of 71 points. This is the highest total for any of the wastewater management alternatives evaluated. WMA-2 affords the most protection to the natural environment. However, a potential impact which may not be reflected in this evalution is the possible negative impacts due to unchecked development along Rt. 70 encourage by providing wastewater facilities in the area. Runoff from parking lots and other development may be just as, if not more damaging to cave systems than the relatively few septic tank systems now in the area.

Wastewater Management Alternative 3 - WMA-3 is very similar to WMA-1 in treatment and disposal options and is identical in the natural environment evaluation parameter rates, total score and environmental ranking. WMA-3 does not include provisions for sewering the existing development along Rt. 70. This alternative does include the Green River discharge point and the elimination of current subsurface effluent discharges. Highly significant, beneficial impacts are anticipated for the free flowing groundwater quality, ground water supplies, rare and endangered species and odor parameters; significant, beneficial impacts are noted for the diffuse groundwater quality, cave biological systems and "sensitive areas" parameters; and moderate, negative impacts are noted for free-flowing groundwater quality, wildlife and soils parameters.

Wastewater Management Alternative 4 - The treatment conveyance and disposal options for Cave City, Horse Cave and Munfordville in WMA-4 are identical to those in the first three alternatives. As in WMA-2, the development along Rt. 70 is to be sewered and a treatment facility is specified for the Chaumont area. The major difference between WMA-4 and WMA-2 concerns Park City. WMA-4 does not include Park City in the effluent disposal system discharging to the Green River. Instead, WMA-4 specifies for Park City conventional and alternate on-lot treatment systems and a small community, low pressure sewer system with a community soil absorption field to serve the business section.

These basic similarities are reflected in the identical ratings for several parameters in the evaluations of WMA-4 and the first three alternates. Like WMA-2, WMA-4 offers increased protection of sensitive areas due to the sewering of Rt. 70. This is reflected in the highly significant, beneficial rating for this parameter. It also provides for potential negative impacts due to unchecked development along Rt. 70 as previously mentioned. The on-lot systems and the community soil absorption field will produce significant beneficial impacts to the groundwater supplies, the diffuse groundwater quality and the cave biological systems. These parameters are rated slightly less beneficial than in WMA-2 due to the impact of possible system failure. The rating of the groundwater supply parameter is less for WMA-4 than for the first three alternatives. This again reflects the local disposal option of WMA-4.

Wastewater Management Alternative 5 - The Cave City, Horse Cave and Munfordville components of WMA-5 are identical to those in the first four alternatives. All these alternatives call for the upgrading of the Cave City and Horse Cave treatment plants to secondary treatment with Class III reliability, the transport of treated effluent from Cave City and Horse Cave to the Green River and additional on-lot treatment systems at Munfordville. The Staging Area option is that of WMA-3, composting waterless toilets with septic tank/soil absorption system for grey water. The WMA-5 option for Park City include conventional and alternate on-lot systems along with a community soil absorption field as in WMA-4. The major environmental benefits of WMA-5 are associated with the change from subsurface effluent discharges for Horse Cave and Cave City. The alternative does not transport effluent for the entire area to the Green River, nor does the alternative provide for wastewater service in the existing development along Rt. 70.

These similarities are reflected in the natural environmental ratings for WMA-5. The beneficial impact on groundwater supplies is assessed as significant as in WMA-4. The rating of a significant beneficial impacts on Rare and Endangered Species is less than the highly significant rating assessed in the first four alternatives and reflects the impacts of the local treatment and disposal options and the development along Rt. 70. The decrease in the amount of pipeline construction reduces the negative impacts to Terrestrial Vegetation and Soils from moderate to slight.

WMA-5 has a total environmental evaluation score of 59 points and is ranked fifth of the eight wastewater management alternatives.

Wastewater Management Alternative 6 - WMA-6 is distinct from all previous alternatives in that the effluent from the Cave City treatment facility is not pumped to Horse Cave and ultimately to the Green River. The combined effluents from the Park City treatment facility (0.08 MGD-extended aeration) and the Cave City treatment facility (upgraded to provide secondary-plus treatment, Class I reliability) are disposed of by subsurface discharge. The Horse Cave facility is to be upgraded to secondary treatment and Class III reliability with discharge to the Green River. Local disposal options are proposed for the Staging Area (waterless toilets/soil absorption system) and Munfordville (on-lot systems).

The environmental evaluation ranks WMA-6 as the seventh most desirable of the eight systems evaluated with a total evaluation score of 46 points. The only parameters with highly significant beneficial ratings are diffuse groundwater quality and odor. These ratings are due to the removal of the Horse Cave discharge and the improvement of conditions in Park City. The lower total environmental evalution score is caused by the lower scores in the free flowing groundwater quality parameter and the cave biological systems parameter. These two parameters are assessed as moderately beneficial as opposed to significant or highly significant as in the previously discussed waste water management alternatives. The upgrading of the Cave City facilities is expected to significantly improve the quality of the effluent and the reliability of treatment. This is expected to have a moderately beneficial effect on the cave systems and free flowing groundwater quality. The lower evaluation score also reflects the fact that the development along Rt. 70 is not sewered in WMA-6.

Wastewater Management Alternative 7 - WMA-7 has a total environmental evaluation score of 37 points and is ranked sixth out of eight alternatives. This alternative includes local treatment and disposal options for Park City and Munfordville, local treatment for Horse Cave with disposal to the Green River and a combined Staging Area-Cave City system. This combined system includes the sewering of development along Rt. 70, a treatment facility near Chaumont, upgrading the facility at Cave City and a disposal system consisting of spray irrigation and subsurface discharge. This disposal system would utilize spray irrigation land application for dry season operation and subsurface discharge for wet season operation. The disposal option provides significant beneficial impacts to the cave biological systems and the free flowing groundwater quality. The land disposal of effluent removes the current subsurface discharge at Cave City during that part of the year when groundwater base flow conditions and minimal dilution are present. The peak period of flow from the Staging Area will also coincide with these conditions. Effluent, therefore, is to be disposed of on land during this critical period. During the wet season groundwater levels and therefore dilution factors are elevated and flows from the staging area are reduced. The negative impacts on cave systems and groundwater quality is thereby reduced. The diffuse groundwater quality and cave biological systems parameters are also benefited by providing wastewater services to Rt. 70 development.

Wastewater Management Alternative 8 - This final alternative has the lowest total environmental score (40 points) and is the least desirable (with respect to impacts on the natural environment) of the eight alternatives. WMA-8 calls for local treatment options at all sites with local disposal options at all sites except Horse Cave. The Horse Cave disposal option discharge to the Green River while the Cave City option is year-round subsurface discharge. Overall the alternative provides the least benefit for the groundwater quality, groundwater supplies, cave biological systems, rare & endangered species and sensitive area" parameters.

Summary

The natural environmental evaluation scores indicate that the eight wastewater management alternatives cluster into three groups. The most desirable alternative is WMA-2 which is eight points above the second best alternative. The second through sixth ranked alternatives (WMA-4, WMA-1, WMA-3, WMA-5, WMA-7) are roughly equivalent being separated by six points. The final two alternatives (WMA-6, WMA-7) are clearly the least desirable with total environmental evaluation scores of less than 50 points.

Man-Made Environment

As with the Natural Environment the same methodology is used to measure the potential impacts of the wastewater management alternatives upon the man-made environment. The following is a listing of the man-made parameters which will be used in this analysis. These parameters are summarized in Table III-9 along with their weighting factors and major impact sources.

Population: One of the major features of developing new or expanded wastewater facilities are the impacts upon population growth. Wastewater facilities serve as a stimulus to population growth which in turn impact a variety of man-made features. However, in the Mammoth Cave area it is not expected that extensive population growth will result from any new wastewater facilities. First, population projections for the area are conservation. Secondly, the proposed wastewater facilities will include only limited new service areas and, therefore, will not act as a direct stimulus to population growth. While impacts upon population growth will need to be observed, we do not see it as a significant factor. Therefore, the parameter has been assigned a weight of "2" - moderate.

Land Use: Contrary to the impacts upon population, we do feel that significant impacts upon land use could occur. As new wastewater facilities and collection facilities are made available they will serve to stimulate the recreational based industry in the area. Furthermore, some industrial development activity could occur because of improved treatment, expanded capacity of the wastewater systems and resolution of the disposal problem. Depending upon which wastewater management alternative is selected, there could be substantial land use impacts in all of the I-65 interchange areas in the area along U.S. Route 70. Land use has been assigned a weight of "3" - significant.

Community Services and Facilities: Community services include health care, education, and libraries, fire protection, police protection and the administrative stucture to manage those services. Impacts to community services are associated with increased population size. Since population increases are not projected to be significant, the requirements for expanded community services and facilities should not be significant. Therefore, this parameter has been assigned a weight of "2" - moderate.

TABLE III-9

MAN-MADE ENVIRONMENTAL EVALUATION PARAMETERS AND WEIGHTS FOR THE MAMMOTH CAVE AREA EIS

Parameter	Weight	Major Impact Sources
Population	2	Population growth, residential development, construction of wastewater facilities
Land Use	3	Population growth, wastewater facilities construction
Community Services & Facilities	2	Population growth, land use changes, construction facilities
Historical, Culturial & Archeological Resources	3	Wastewater facility construction
Recreational Resources	4	Population growth, land use changes, construction activities
Economics	2	Population growth, land development
Transportation	1	Wastewater facilities construction, population growth

Historical, Cultural and Archeological Resources: This parameter includes an evaluation of the wastewater management alternatives upon the cultural resources and historical and archeological sites located within the study area. Mammoth Cave National Park is primarily a natural resource. However, it also must be considered a cultural resource and will be given adequate attention in this section. There are also numerous archeological and historical resources within the study area. Therefore, this parameter has been assigned a weight of "3" - significant.

Recreational Resources: Recreation is a vital factor in the study because of the Mammoth Cave National Park and the supporting facilities and services. Recreation oriented business is the major industry in the study area. Any wastewater management plan has the potential to impact recreational activities and resources. Due to recreation's importance and influence in the area, a weight of "4" - highly significant has been assigned to this parameter.

Economics: The impact upon the local economy will come from both the short term construction impacts and the long term investment from the installation of wastewater facilities. Wastewater facilities in the study area should stimulate positive economic growth in the study area. A weight of "2" - moderate has been assigned to this parameter.

Transportation Facilities: Transportation facilities can be impacted through construction activities and increased demand associated with secondary growth. The latter development is not anticipated. It is possible that some interruption of normal highway traffic could be caused by pipeline construction. Because of the limited scale of such an interruption, the parameter has been assigned a weight of "1" - slight.

Man-Made Environmental Impacts Evaluation. Results of the man-made environmental impacts evaluation for the eight wastewater management alternatives are presented in Table III-10. This table provides the evaluation score for each alternative as well as its ranking with respect to anticipated effects upon the man-made environment. In addition, Table III-11 provides the breakdown of the evaluation scores by parameter.

4. OPERABILITY

Evaluation of operability of the proposed wastewater management systems should include consideration of the following aspects:

- reliability of treatment
- flexibility of operation
- maintainability of facilities

In the evaluation of reliability the ability of the facilities in the treatment schemes to maintain the intended treatment levels is considered. Operational flexibility is a measure of the ability of

TABLE III-10

WASTEWATER MANAGEMENT ALTERNATIVES (WMA) MAN-MADE ENVIRONMENTAL IMPACTS EVALUATION RESULTS & RANKING

WMA Number	WMA Designation	Evaluation Scores	Environmental Ranking
1	(SA-PC-CC-HC-)2, MN-1	15	4
2	(PC-SA-CC-HC)2, MN-1	20	1
3	SA-1, (PC-CC-HC)3, MN-1	15	4
4	PC-2, (SA-CC-HC)3, MN-1	20	1
5	SA-1, PC-2, (CC-HC)8, MN-1	15	4
6	SA-1, (PC-CC), HC-4, MN-1	15	4
7	PC-2, (SA-CC)1, HC-4, MN-1	18	3
8	PC-1, SA-1, CC-1, HC-4, MN-1	11	8

TABLE III-11

MAN-MADE ENVIRONMENTAL IMPACTS EVALUATION SCORING

		WASTEWATER MANAGEMENT ALTERNATIVES															
		1		2		3		4		5		6		7		8	
		(SA-PC-CC-HC)2 MN-1		(PC-SA-CC-HC)2 MN-1		SA-1 (PC-CC-HC)3 MN-1		PC-2 (SA-CC-HC)3 MN-1		SA-1, PC-2 (CC-HC)8 MN-1		SA-1 (PC-CC)2, HC-4 MN-1		PC-2 (SA-CC)1 HC-4, MN-1		PC-1, SA-1 CC-1, HC-4, MN-1	
Parameters	Weight	Rate	Score	Rate	Score	Rate	Score	Rate	Score	Rate	Score	Rate	Score	Rate	Score	Rate	Score
Population	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Land Use	3	1	3	2	6	1	3	2	6	1	3	1	3	2	6	1	3
Community Services and Facilities	2	1	2	2	4	1	2	2	4	1	2	1	2	1	2	0	0
Historical, Cultural and Archeological Resources	3	-1	-3	-1	-3	-1	-3	-1	-3	-1	-3	-1	-3	-1	-3	0	0
Recreational Resources	4	2	8	2	8	2	8	2	8	2	8	2	8	2	8	1	4
Economics	2	2	4	2	4	2	4	2	4	2	4	2	4	2	4	1	2
Transportation Facilities	1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	0
TOTAL			15		20		15		20		15		15		18		11

wastewater treatment components to adopt to changes in wastewater characteristics and the ability of the wastewater management system to serve future development areas and to undergo upgrading and/or expansion to comply with changes in water quality goals. Maintainability considerations include the complexity of equipment, frequency of maintenance down time, and efficiency of providing required maintenance.

In order to provide a comparative operability ranking of the eight wastewater management alternatives, a numerical rating system is developed which combines ratings for each of the above factors into a total operability score.* The rating system provides for a maximum possible operability score of 100 points. Flexibility, reliability and maintainability are weighted at thirty (30), forty (40) and thirty (30) points respectively, thus, indicating reliability to be the most significant factor. For any given alternative each operability factor is rated on a scale of 1 to 10, ten (10) being excellent and one (1) being poor. This rating is multiplied by the weighting proportion to determine the score. For example a reliability rating of 6, translates to a score of 24

$$\left(\frac{6}{10} = \frac{24}{40}\right)$$

The basic assumptions used in determining operability ratings for wastewater management alternatives** are as follows:

- Facilities with lower treatment levels are more reliable and easier to maintain than those with higher treatment levels. However, on-lot systems are considered more difficult to maintain, even though treatment levels are low, because of the large number of individuals responsible for maintenance. However, if EPA funds on-lot systems a management maintenance program would be required. Such a program would minimize potential maintenance problems.

- Joint wastewater treatment/disposal is considered to be more flexible and reliable than local treatment/disposal but less maintainable because of the conveyance facilities (especially pumping stations) required.

- Composting waterless toilets are considered to be less reliable and maintainable than conventional systems because of their operational unknowns for large-scale usage. They are considered to be equally flexible as conventional systems.

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* Operability evaluations for selection of local and joint wastewater treatment/disposal options are preferred in a similar manner. Results appear in Appendix III.

** These include both general assumptions and those specific to the Mammoth Cave Area wastewater management alternatives. Additional general assumptions applicable to the selection of treatment/disposal options are presented in Appendix III.

- Spray irrigation of effluent is less reliable and flexible than discharge to surface waters. (This evaluation is based, in part, on the operational unknowns associated with the soils and topographic conditions at potential land application sites).

The results of the operability evaluation are presented in Table III-12. Wastewater management alternatives 1 and 2 are considered to be the most operable, each receiving a rating of 80. The high ratings are due partly to the fact that the systems are considered highly reliable since combining wastewaters from all the population centers reduces the chances of a discharge that greatly exceeds secondary treatment levels. In addition, these alternatives are considered highly reliable since only secondary treatment levels are to be maintained. In addition, the impact of failure by one of the treatment facilities in the joint treatment/disposal system may be greatly reduced because of the dilution factor provided by the other treated wastewaters prior to discharge. Alternative 2 is considered to provide the greatest flexibility since it appears to have the greatest potential to serve any future development in the study area. Alternative 1, however, is considered more maintainable because it has one less treatment facility and one less pumping station than Alternative 2.

The lowest operability rating is assigned to Alternative 8, the "local" alternative. The reliability rating is lower primarily because of the waterless composting toilets at the Staging Area and the higher degree of treatment (advanced secondary) required at Cave City. This method of providing wastewater treatment is also considered least flexible in that it doesn't provide as well for serving future growth areas. This system is considered to be reasonably maintainable since there are no pumping stations and conveyance systems to maintain, however, the anticipated difficulty is maintaining the individual septic tanks and low pressure sewer system in Park City prevent a higher maintainability rating.

5. IMPLEMENTABILITY

The practicalities of implementing a specific wastewater management plan must be considered, together with cost, environmental impacts and operability evaluations, as an important part of the cost-effectiveness analysis. The purpose of the implementability rating is to assess the prospects for successful implementation of an alternative based on its potential for general public acceptance and political realities in the study area.

Unlike the other evaluation in the cost-effectiveness analysis (costs, environmental impacts & operability), the implementability rating is not independent, but is somewhat dependent on the results of the other evaluations. This is especially the case with public acceptance since costs and environmental impacts evaluations probably have the greatest influence on public acceptability. For example, if an environmentally favorable plan is significantly more costly, the

TABLE III-12

OPERABILITY EVALUATION COMPARISON
MAMMOTH CAVE AREA WASTEWATER MANAGEMENT ALTERNATIVES

Wastewater Management Alternative	Reliability	Flexibility	Maintainability	Total	Operability Ranking
Alternative 1 $(SA\text{-}PC\text{-}CC\text{-}HC)^2$, MN-1	32	24	24	80	1
Alternative 2 $(PC\text{-}SA\text{-}CC\text{-}HC)^2$, MN-1	32	27	21	80	1
Alternative 3 SA, $(PC\text{-}CC\text{-}HC)^3$, MN-1	38	18	21	67	3
Alternative 4 PC-2, $(SA\text{-}CC\text{-}HC)^3$, MN-1	32	21	15	68	2
Alternative 5 SA, PC-2, $(CC\text{-}HC)^8$, MN-1	24	15	18	57	5
Alternative 6 SA, $(PC\text{-}CC)^2$, HC-4, MN-1	24	15	21	60	4
Alternative 7 PC-2, (SA-CC), HC-4, MN-1	20	21	15	56	6
Alternative 8 PC-2, SA, CC-3, HC-4, MN-1	20	12	18	50	7

public must decide how much it is willing to pay (in terms of monetary costs) for environmental benefits.

Since implementability is dependent on results from other cost effectiveness evaluations it does not appear prudent to attempt to gauge public acceptance or to account for political considerations before these other evaluations are presented to the public as part of the public participation program.

An important factor in public acceptance is the local annual cost associated with a wastewater management alternative. The local annual cost includes annual operation and maintenance costs plus the annualized local share of the cost of constructing the wastewater facilities. This is a measure of annual revenue requirements, and therefore, the actual cost to the users. Since construction costs are 75 percent federally funded and local operation and maintenance costs are subsidized, projects with high construction and low operation and maintenance costs sometimes have lower local annual costs even though they are higher on a net present worth basis than other plans with greater operation and maintenance costs and lower construction costs. Table III-13 presents a breakdown of estimated annual costs, by population center* for each wastewater management alternative. The assumptions for developing these local annual costs are as follows:

- All project costs are considered to be grant eligible with the exception of interest during construction (5 percent of construction costs).
- Construction costs for individual on-lot systems are not grant eligible if certain conditions are met. (See PRM 79-8)
- Spray irrigation and pre-treatment facilities are eligible for 85% funding.
- The Staging Area (National Park Service) is not eligible for an EPA grant and bears 100 percent of its share of construction costs.
- For joint treatment disposal, each participating population center pays a percentage of local annual costs (based on estimated design flows) for only those wastewater facilities that handle its wastewaters.

A complete development of these costs is presented in Appendix III.

Rankings of alternatives based on total local annual costs and local annual costs excluding the National Park Staging Area are presented in Table III-14. It is evident that, because of the lack of EPA funding for the Staging Area, local annual costs for the entire

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* The Rt. 70 development area is listed as a population center since is is expected that this area will pay its share of the costs for wastewater facilities it included in the service area of a wastewater management system.

TABLE III-13
WASTEWATER MANAGEMENT ALTERNATIVES
LOCAL ANNUAL COSTS BY POPULATION CENTER

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8
*Staging Area	234,000	162,000	42,000	201,000	42,000	42,000	187,000	42,000
Park City	128,000	149,000	150,000	50,000	50,000	144,000	50,000	50,000
Cave City	131,000	123,000	134,000	129,000	143,000	124,000	96,000	128,000
Horse Cave	141,000	139,000	141,000	140,000	145,000	158,000	158,000	158,000
Munfordville	56,000	56,000	56,000	56,000	56,000	56,000	56,000	56,000
Rt. 70 Development	-	50,000	-	57,000	-	-	51,000	-
	690,000	679,000	523,000	633,000	436,000	524,000	598,000	434,000

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*EPA Construction Grants are not available for federal facilities contributing greater than 5 percent of the total flow (EPA PRM 75-35, December 29, 1978).

TABLE III-14
WASTEWATER MANAGEMENT ALTERNATIVES
LOCAL ANNUAL COSTS RANKING

	Total Annual Local Costs	Ranking	Local Annual Costs Excluding the National Park Staging Area	Ranking
Alternative 1 (SA-PC-CC-HC)^{2}, MN-1	$690,000	8	$456,000	5
Alternative 2 (PC-SA-CC-HC)^{2}, MN-1	678,000	7	517,000	8
Alternative 3 SA, (PC-CC-HC)^{3}, MN-1	523,000	3	481,000	6
Alternative 4 PC-2, (SA-CC-HC)^{3}, MN-1	633,000	6	432,000	4
Alternative 5 SA, PC-2, (CC-HC)^{8}, MN-1	436,000	2	394,000	2
Alternative 6 SA, (PC-CC)^{2}, HC-4, MN-1	524,000	4	482,000	7
Alternative 7 PC-2, (SA-CC), HC-4, MN-1	598,000	5	411,000	3
Alternative 8 SA, PC-2, CC-3, HC-4, MN-1	434,000	1	392,000	1

area do not necessarily provide an appropriate basis for comparison of the actual annual costs to the study area residents. It is anticipated that after public review and comment regarding this and other cost-effectiveness evaluations, a completed implementability rating will be developed.

PART E. NO-ACTION ALTERNATIVE EVALUATION

A requirement of the EIS process developed by EPA is that a no-action alternative will be considered along with other wastewater facilities alternatives. The no-action alternative implies that no federal funding would be available for wastewater facilities in the Mammoth Cave area. Under this alternative, improvement and/or expansion of the wastewater facilities would be required but there would be no federal funds provided for design and construction of the facilities.

A no-action alternative does not imply no-growth. Growth would continue but any wastewater functions would be supported by private capital, or local and state funding. However, a no-action alternative could possibly alter growth throughout the area. Under the concept of no action there would be complete reliance upon state, local or private funds to finance any wastewater management facilities. However, without the support of federal funds, the level of additional wastewater facilities would be significantly different than under any of the other wastewater management alternatives.

Under a no-action scenario it is likely that most future sewage treatment and disposal needs would be accommodated by either privately owned package treatment plants or individual on-lot treatment systems. It is unlikely that any of the communities in the study area would be financially able to undertake any significant expansion of their wastewater facilities. This alternative would impact the rate of growth, the pattern of growth and the overall cost of wastewater management.

The missing component in this alternative is the federal share of capital funding for wastewater management. Considering the magnitude of the capital cost of any structural wastewater management systems for the basin, it is highly unlikely that any such system could be constructed if 100% of the cost had to be borne by state and local governments. A review of the cost of the 8 wastewater management alternative reveals that alternative 8, the so-called "local alternative" has the least net present worth of $7,630,000. However, the local communities in the study area would be hard pressed to finance even this level of funding. Despite these problems, it is reasonable to expect that other methods of sewage treatment would emerge in response to development pressures.

The no-action alternative would result in very little activity by the local municipalities to either upgrade or expand their facilities. Even enforcement actions by the Commonwealth of Kentucky or EPA might have little impact without the influence of funding. The following is a portrayal of the impacts of a no-action alternative on each community in the study area.

Horse Cave. The major problems at Horse Cave are associated with the industrial wastewater discharged into the plant. This results in poor treatment and, therefore, degradation of the entire Hidden River Cave environment. Under a no-action scenario we would assume that the major improvements to the plant would be through operation and maintenance of the present plant. However, the community could take action to resolve the industrial waste problem by instituting and enforcing a strong sewer use ordinance and restricting the loadings from both Ken-Dec and the Hart County Creamery. With the industrial waste problem resolved, treatment levels at the plant would improve, but not to the degree necessary to be consistent with the waste load allocations. However, under this alternative, disposal would continue into the Hidden River complex and would not resolve the environmental conflicts which occur in that cave system.

There is some excess capacity at the Horse Cave treatment plant which would be available for limited residential or industrial development. However, most new growth would require the use of on-lot systems which, in turn, would have a further negative environmental impact upon the study area.

Munfordville. A no-action alternative would most likely have little influence upon Munfordville. Proposed expansion of the collection system might be sacrificed although the community may elect to finance this program locally. However, it is more likely that a no-action alternative would cause a proliferation of conventional and alternate on-lot wastewater treatment and disposal systems.

Cave City. The Cave City wastewater treatment plant is currently not providing the level of treatment required by the NPDES permit. According to the EIS analysis of the plant, operations improvements are necessary to maintain secondary treatment levels, but significant process changes are required to meet NPDES permit conditions.

Under a no-action scenario it is unlikely that funds would be available to undertake any process changes, therefore the plant would continue to operate in violation of the NPDES permit. This will continue to adversely impact the Hidden River Cave system which received the treated effluent from the Cave City treatment plant. Flow records from 1977 indicate that the plant was approximately 0.1 mgd less than the plant's design capacity of 0.32 mgd. This would allow additional capacity for residential and commercial development especially that associated with the tourism industry in the area. However, as flow capacities are attained, development activities would either subside or the use of package plants and on-lot facilities would increase.

Park City. The impact upon Park City of a no-action alternative would be practically negligible, since the community only has on-lot systems. Therefore, the community would continue to utilize its on-lot systems for existing development and for any new development.

In summary, the selection of a no-action alternative would generate the following conditions:

1. Little or no changes in the existing sewage treatment systems. Operational changes could be made but process

changes would be beyond the financial capabilities of the communities. Proliferation of conventional or alternative on-lot disposal systems.

2. Continuation of environmental degradation in the Hidden River Cave complex from inadequately treated wastewater from improperly designed, installed, and operated on-lot systems.

3. Restrictions on residential, commercial and industrial development. Proliferation of package treatment plants and on-lot systems. No-action will also stimulate strip development and scatter development.

ENVIRONMENTAL IMPACT STATEMENT

MAMMOTH CAVE AREA, KENTUCKY

201 FACILITIES PLAN

ALTERNATIVES EVALUATION TECHNICAL REFERENCE DOCUMENT

APPENDIX III

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IV
ATLANTA, GEORGIA 30365

ENVIRONMENTAL IMPACT STATEMENT
ALTERNATIVES EVALUATION TECHNICAL REFERENCE DOCUMENT
APPENDIX III
MAMMOTH CAVE AREA, KENTUCKY
201 FACILITIES PLAN

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PART A. WASTEWATER FACILITIES COST DEVELOPMENT AND EVALUATION

APPENDIX PART A UPDATE

This appendix for the Alternatives Evaluation task report was originally completed in July 1979. Costs were developed for June 1979 using projected EPA cost indices. The assumed year of project construction was 1981.

Delays since the completion of the Alternatives Evaluation report have necessitated updating the cost evaluation of the alternatives. This is because of the following:

- Construction costs have increased by about 14 percent according to EPA construction cost indices used in preparation of the 1979 appendix
- The federal discount rate has increased from 6.875 percent to 7.125 percent
- The planning period is reduced to 17 years (1983-2000), since the assumed year of construction is now 1983 instead of 1981.

The methodology for obtaining the costs for the alternatives evaluation, as prepared in 1979, is presented in this appendix. Cost updates are noted in the text and tables. As indicated, construction costs (and therefore project costs) are increased by 14 percent. For purposes of recosting, O&M costs are assumed to have increased by a similar amount.

WASTEWATER FACILITIES COST DEVELOPMENT AND EVALUATION

Introduction

This section of the appendices contains the assumptions and methodologies used for the development of costs for wastewater facilities. These include the following:

Wastewater Treatment Facilities
Land Application Facilities
Wastewater Collection and Conveyance Facilities
On-lot disposal systems
Waterless Composting toilets

In addition, this section also provides background for cost evaluations, including net present worth and local annual costs analyses.

Wastewater Facilities Cost Development

Wastewater Treatment Facilities

Cost evaluation of alternative wastewater treatment facilities in the Mammoth Cave study area involves developing costs for new wastewater treatment plants as well as costs for upgrading and/or expanding existing treatment plants. In order to provide a basis for a legitimate cost comparison of upgrading/expansion alternatives and new treatment plant alternatives, the costing methodology used as the basis for pricing new treatment facilities must be flexible enough to also provide a basis for pricing treatment plant expansion and/or upgrading. The method used in this study for pricing new plants and expansion and/or upgrading of existing facilities is based on determining costs of the individual units to be constructed.

The costs of the individual treatment units are estimated using cost curves developed in *"Small Community Wastewater Treatment Facilities - Biological Treatment Systems" by Henry H. Benjes, a document prepared for the Environmental Protection Agency technology transfer national seminar on small wastewater treatment systems. The cost curves, based on January 1977 costs, appear to be especially applicable for estimating costs of treatment facilities for the Mammoth Cave area since they deal specifically with costs of small wastewater treatment plants (less than 2 mgd). Benjes' curves, however, are not applicable to all equipment or unit process costs associated with upgrading or optimizing operation of existing wastewater treatment plants. In the few cases that these costs are required, estimates are made based on bid prices for similar projects and engineering experience.

Benjes' unit process cost curves include allowance for all electrical work associated with a treatment unit as well as a 15 percent contingency. Total construction costs include the total unit process costs plus 15 percent of these costs for site improvements (roads, walls, fences, grading, inter-unit piping). Total project costs are generally developed as follows:

. Unit Process Construction Costs (from Benjes' curves)
+. Site Improvements (15% of Unit Process Costs)

SUBTOTAL...Construction Costs

. Construction Costs
. Engineering, Legal, Administrative (25% of construction costs)
. Interest During Construction (5% of construction costs)

---

*Benjes, Henry H., Jr. "Small Community Wastewater Treatment Facilities-Biological Treatment Systems, USEPA Technology Transfer, Design Seminar Handout and Small Wastewater Treatment Facilities, January 1978.

- Land Costs*
- Legal and Financial (7% of land costs)
- Contingencies (5% of land costs)

TOTAL...Project Costs

There are some cost items in plant upgrading which the 15% site improvement mark-up doesn't apply. (eg. aeration equipment). These are added directly to the construction cost. In addition, for some alternatives that involve upgrading existing facilities, the cost estimates provide for a repair contingency. No mark-up for engineering, etc. is included for these costs.

Construction costs used in this study, as originally prepared in June 1979, are adjusted to reflect projected price levels in the Mammoth Cave area for June, 1979. The construction cost index used in this study for estimating treatment plant costs is the EPA small city wastewater treatment plant construction cost index. The cost index value assumed for this study is 139, as prepared in June 1979. The January 1981 estimated cost index to update cost estimates is 159.

Tables AIII-1 through AIII-3 provide a sample determination of project costs for three types of projects, construction of a new treatment facility, upgrading an existing facility, and modification of existing facilities.

Wastewater treatment plant operation and maintenance costs are determined using unit process O&M supply costs and manpower requirements curves

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* Land costs are only considered for spray irrigation or other land application systems, since treatment plant sites are already available and since land costs are not considered a significant part of treatment plant costs in this area.

TABLE AIII-1 EXAMPLE: WASTEWATER TREATMENT FACILITY PROJECT COST ESTIMATE

NEW 0.9 MGD EXTENDED AERATION OXIDATION DITCH PLANT (OPTION (CC-HC)1)

Unit Process	Construction Costs (Reliability, Class III)	Construction Costs (Reliability Class I*)	Construction Cost Curves**	Independent Variable	Approximate Design Assumptions
Raw Sewage Pumping Station	$ 170,000	$ 260,000	Raw wastewater pumping	Firm pumping capacity (mgd)	Peak flow (3.6 mgd)
Preliminary Treatment	92,000	92,000	Preliminary treatment	Peak design flow rate (mgd)	Peak flow (3.6 mgd)
Aeration Basins	140,000	162,000	Oxidation ditch aeration basins	Volume (mg)	24 hours detention at average flow
Aerators	130,000	145,000	Mechanical aeration	Installed horsepower (hp)	1 hp/1,000 cu.ft. basin (mixing)
Secondary Sedimentation	114,000	114,000	Sedimentation basins	Surface area (1,000 sq.ft.)	600 gpd/ft.^{2} surface area
Sludge Pumping	72,000	85,000	Sludge pumping stations	Firm pumping capacity (gpm)	-
Recirculation Pumping	48,000	58,000	Recirculation pumping	Firm capacity (mgd)	-
Chlorine Contact	49,000	60,000	Chlorine contact basins	Volume (1,000 cu.ft.)	30 Min. D.T. at Q peak
Chlorination	27,000	27,000	Chlorine feed equipment	Design feed rate (lbs./day)	10 mg/l at peak flow
Sludge drying beds	51,000	65,000	Sludge drying beds	Area (1,000 sq.ft.)	20 sq.ft./lb/day dry solids
Total	$ 893,000	$1,068,000			
Site Improvements (15%)	$ 134,000	$ 160,000			
Construction Cost (Subtotal)	$1,027,000	$1,228,000			
Engineering, Legal, Administrative, etc. (25%)	257,000	307,000			
Financial (5% Interest During Construction)	51,000	61,000			
TOTAL PROJECT COSTS	$1,335,000	$1,596,000			
Cost Update to January 1981* **	**$1,522,000**	**$1,819,000**			

*Indicates effects of reliability requirements (extra capacity, duplicate units, etc.).

**Unit process cost curves from: Benjes, Henry H., Jr., "Small Community Wastewater Treatment Facilities - Biological Treatment Systems", Design Seminar handout - Small Wastewater Treatment Facilities, EPA Technology Transfer, January, 1978.

*****January 1981 Updated Cost = Estimated June 1979 Cost x $\left(\frac{\text{Jan. 1981 Cost Index}}{\text{June 1979 Cost Index}}\right)$ = Estimated June 1979 Cost x $\left(\frac{159}{139}\right)$ = Estimated June 1979 Cost x 1.14**

TABLE AIII-2 EXAMPLE: WASTEWATER TREATMENT FACILITY PROJECT COST ESTIMATE

UPGRADING HORSE CAVE WASTEWATER TREATMENT PLANT
(0.53 MGD, SECONDARY, CLASS III RELIABILITY)

Upgrading Cost Item	Design Assumptions	Costing Method	Construction Costs
Aerated industrial wastewater equalization basin	24-hour detention @250,000 gpd average flow; concrete lined earthen basin	Benjes' cost curves "Custom Built Aeration Basins"	$ 37,000*
Basin aeration equipment	Mechanical aeration; 1 hp per 1,000 ft.^{3}	Benjes' cost curves "Mechanical Aeration"	40,000
Piping for equalization basin	140 ft. of 12-inch gravity pipe	Engineering estimate based on similar projects	8,000
Second-stage biological treatment activated sludge basin	4-hour detention @ 0.53 mgd average flow; concrete lined earthen basins	Benjes' cost curves "Custom Built Aeration Basins"	28,000*
Aeration equipment (activated sludge)	Mechanical aeration, 1 hp per 1,000 ft.^{3}	Benjes' cost curves "Mechanical Aeration"	32,000
Pumping to activated sludge basins	2- Screw lift pumps	Engineering estimate based on similar project	86,000*
Secondary clarifier	600 gpd/ft^2 @.265 mgd	Benjes' cost curves "Sedimentation Basin"	59,000*
Recirculation pumping	$Q_r/Q = 0.5$ or $Q_e = 0.265$ mgd	Benjes' cost curves "Recirculation Pumping"	62,000*
Sludge drying beds	Approximately 20 sq.ft./lb/day dry solids	Benjes' cost curves "Sludge Drying Beds"	12,000*
Chlorination	10 mg/l at Q peak	Benjes' cost curves "Chlorine Feed Equipment"	24,000*
Chlorine contact tank	30 minutes detention at Q peak	Benjes' cost curves "Chlorine Contact Basins"	48,000*
		Construction Costs	$ 436,000
		Project Overhead (30%)	131,000
		Estimated Contingency for Repairs	75,000
		Total Estimated Project Cost	$ 642,000
		Cost Update to January 1981**	**$ 732,000**

*Includes 15 percent for site improvements.

****January 1981 Updated Cost= Estimated June 1979 Cost x 1.14**

TABLE AIII-3

EXAMPLE: WASTEWATER TREATMENT FACILITY PROJECT COST ESTIMATE

MODIFICATIONS FOR MAXIMUM TREATMENT AT CAVE CITY USING EXISTING FACILITIES

Cost Item and Cost Breakdown		Construction Cost	Project Cost
Recirculation Pumps (GFC&C Estimate)		$ 23,000	$ 30,000
2 Pumps @ 6,000	$ 12,000		
Installation (25%)	3,000		
Electrical	2,000		
Subtotal	$ 17,000		
Overhead, Insurance ,Taxes (20%)	$ 3,400		
Profit (15%)	2,550		
Total	$ 22,950		
	Say $ 23,000		
Conversion of Digester to Aerobic		$ 22,000	$ 26,000
Removal of floating cover	$ 5,000 (201 Plan)		
Piping changes	- (201 Plan)		
25 hp Floating aerator with draft tube and variator installed	10,000 (201 Plan)		
Cleaning digester before conversion	1,500 (GFC&C)		
Subtotal	$ 16,500		
Overhead, Insurance, Taxes (20%)	3,300		
Profit (15%)	2,475		
Total	$ 22,000		
Installation of Air Injection System to Primary Clarifier (201 Estimate)		$ 3,000	$ 4,000
Estimated Contingency for Repairs		-	$ 50,000
TOTAL PROJECT COSTS			$ 113,000
TOTAL PROJECT COSTS (January 1981)*			$ 129,000

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*January 1981 cost = Estimated June 1979 cost x 1.14

contained in the Benjes' report. (Example O&M cost calculations appear in Tables AIII-4 - AIII-5). Electrical power costs are determined based on estimated plant energy requirements as indicated in the Benjes' reports and as estimated based on equipment horsepower. Labor and power cost estimates are based on $7 per man-hour and $0.04 per KWH, respectively. With the exception of power costs, treatment plant annual operation and maintenance costs estimates are based on design flows. Power costs are based on estimated 1990 average flows (assumed average for the planning period) since they appear to be the only major O&M cost component, significantly affected by flow. A comparison of actual 1978 operation and maintenance costs for the Cave City wastewater treatment plant and O&M costs developed for existing facilities using Benjes' O&M curves indicates reasonably good agreement with respect to supply and equipment costs. However, labor costs differ. This is primarily because Benjes' level of labor effort is greater than that presently used at the plant (according to present salaries paid) and because the assumed $7/MH for wages, and benefits is higher than the existing rate of approximately $5.45. The Benjes' labor estimates are used for O&M cost estimates (even for existing plants) for consistency in alternatives comparison and because they appear to indicate a more desirable level of staffing than presently provided at the local treatment plants. The higher wage rate is used to reflect anticipated increases in wages and benefits due to the additional technical and managerial responsibilities associated with operating new or upgraded wastewater facilities.

Land Application Facilities

Wastewater treatment options in this study include spray irrigation land application systems at Park City, Cave City and Horse Cave. Locations of potential spray irrigation sites adjacent to these municipalities are indicated in

TABLE AIII-4 EXAMPLE: WASTEWATER TREATMENT FACILITIES OPERATION AND MAINTENANCE COST ESTIMATE

NEW 0.9 MGD EXTENDED AERATION OXIDATION DITCH TREATMENT PLANT

Unit Process	Independent Variable (Benjes' Cost Curves)	Operation and Maintenance Cost Estimates: Labor	Operation and Maintenance Cost Estimates: Supplies	Operation and Maintenance Cost Estimates: Estimated Total
Raw Sewage Pumping Station	Firm pumping capacity (mgd)	$ 1,400	$ 800	$ 2,200
Preliminary Treatment	Average Design flow rate (mgd)	3,100	1,400	4,500
Aeration Basins (Mechanical Aeration)	Installed horsepower (hp)	12,200	-	12,200
Aeration Basins	Volume (mg)	-	2,000	2,000
Sludge Pumping	Firm pumping capacity (gpm)	3,800	1,200	5,000
Secondary Sedimentation	Surface area (sq.ft.)	6,900	800	7,700
Recirculation Pumping	Firm pumping capacity (mgd)	1,000	200	1,200
Chlorination	Chlorine use (lbs/day)	2,700	1,400	4,100
Chlorine Supply*	Chlorine use (lbs/day)	-	2,700	2,700
Sludge Drying Beds	Dried solids Applied (lbs/day)	4,400	400	4,800
Administration	Plant size (mgd)	3,000	2,000	5,000
Laboratory Analysis	Number of sampling points (Assume 2 pts, 120 days/year)	3,500	1,300	4,800
Yard Work	Plant Size (acres) (Assume 4 acres)	700	1,100	1,800
Power Requirements**	KWH	-	36,000	36,000
Total				$ 94,000
		Updated January 1981 Cost***		$107,000

*Chlorine supply costs based on 8 mg/l dosage and chlorine costs of $250/ton.

**Power requirements (KWH/year) based on 0.7 mgd average flow for the planning period and interpolation between Benjes' estimates for 0.5 and 1 mgd plants.

***Updated January 1981 Costs = Estimated June 1979 Costs x 1.14

TABLE AIII-5 EXAMPLE: WASTEWATER TREATMENT FACILITIES OPERATION AND MAINTENANCE COST ESTIMATE

UPGRADED HORSE CAVE WASTEWATER TREATMENT PLANT (SECONDARY; CLASS III RELIABILITY)

DESIGN FLOW = 0.53 MGD

	Unit Process	Independent Variable (Benjes' Cost Curves)	Operation and Maintenance Cost Estimates		
			Labor	Supplier	Total
EXISTING FACILITY	Preliminary Treatment	Average design flow rate	$2,100	$ 1,200	$ 3,300
	Primary Clarifier	Surface area (sq.ft.)	3,200	300	3,500
	Sludge Pumping	Firm pumping capacity	2,200	400	2,600
	Trickling Filter	Volume (1,000 cu.ft.)	1,100	500	1,600
	Recirculation Pumping	Firm pumping capacity (mgd)	1,100	400	1,500
	Secondary Clarifier	Surface area (sq.ft.)	2,900	300	3,200
	Sludge Pumping	Firm pumping capacity (gpm)	2,600	600	3,200
	Anaerobic Digester	Volume (1,000 cu.ft.)	2,900	1,400	4,300
	Sludge Drying Beds	Dried solids applied (lbs./day)	2,000	200	2,200
	Chlorination	Chlorine use (lbs/day)	1,600	1,100	2,700
	Chlorine Supply*	Chlorine use (lbs/day)	-	1,200	1,200
	Administration	Plant size (mgd)	2,100	1,500	3,600
	Laboratory	Number of sampling points	3,500	1,000	4,500
	Yard Work	Plant size (acres)	600	800	1,400
	Power Requirements**	KWH	-	4,500	4,500
	Subtotal Existing Plant				$43,300
UPGRADING ADDITIONS	Equalization Basin	Installed horsepower and volume (mg)	$2,200	$ 1,100	$ 3,300
	Raw Wastewater Pumping	Firm pumping capacity (mgd)	900	200	1,100
	Activated Sludge Aeration Basin (Mechanical Aeration)	Installed horsepower (hp)	2,000	-	2,000
	Activated Sludge Basin	Volume (mg)	-	700	700
	Secondary Clarifier	Surface Area (sq.ft.)	2,800	300	3,100
	Recirculation Pumping	Firm pumping capacity (mgd)	800	200	1,000
	Sludge Pumping	Firm pumping capacity (gpm)	2,200	400	2,600
	Additional Power Requirements***	KWH	-	10,400	10,400
	TOTAL				$67,500
				Updated January 1981 Cost****	**$77,000**

*Chlorine supply costs based on 8 mg/l dosage and $250/ton of chlorine.

**Power requirements based on Benjes' estimate of 250,000 KWH/mgal for trickling filter plants and an average flow during the planning period of 0.45 mgd.

***Additional power requirements determined by estimate of additional horsepower of new equipment, 15 hp (aeration basin), 5 hp (additional pumping), 20 hp (equalization basin).

****Updated January 1981 Costs = Estimated June 1979 Cost x 1.14

the Mammoth Cave Area EIS Alternatives Development Technical Reference Document. Although more site specific investigation is required, all information indicates that each of the areas appears to have suitable soils and slopes for accommodating a spray irrigation systems.

Costs for the major components of the spray irrigation systems are obtained primarily from Costs of Wastewater Treatment by Land Application, EPA-430/9-75-003, 1976. This publication provides cost information for the individual components utilized in land application evaluation. Both capital costs, and operation and maintenance costs are included. Most of the cost curves in this publication are based on the EPA Sewer Construction Cost Index, however, costs for pumping facilities are based on the EPA Sewage Treatment Plant Construction Cost Index. Projected June, 1979 values for these indices used for this study are as follows:

		3rd Quarter 1980	Projected January 198
EPA Sewer Construction Cost Index -	327	371	373
EPA Sewage Treatment Plant Construction Cost Index -	310	348	353

(Projected January 1981 approximately 14 percent greater than 1979 costs)

The components and design assumptions used in the estimation of spray irrigation system costs are as follows:

1) Land - Land costs are based on total land required, including area for spray irrigation, buildup, roads, storage and a 100 ft. peripheral buffer. The annual average application rate considered for Park City is 2 inches per week. The application rate assumed for Cave City and Horse Cave is 3 inches per week since spray irrigation is to only occur during the dry months of the year at these locations. Year 2000 design flows are considered. Land costs are estimated to be $1500/acre.

2) Storage Pond - A storage pond with a maximum storage capacity of 40 days' winter wastewater flows is used for cost estimates for the Park City System, based on the maximum storage requirement for Bowling Green, Kentucky indicated in "Use of Climatic Data in Estimating Storage Days for Soil Treatment Systems", EPA-600/2-76-250. Since Horse Cave and Cave City systems are to operate only during the dry months of the year, a seven day storage capacity is assumed to be adequate.

3) Field Preparation - Costs include site clearing and land leveling. Spray site clearing costs are based on clearing grass sites.

4) Transmission Pumping - Transmission pumping facilities are sized based on peak flows and assumed total dynamic head values based on elevations and transmission main sizes. Power costs for transmission pumping are estimated based on 1990 average flows.

5) Transmission Mains - Transmission main sizes are based on maintaining flow velocities of 3-5 fps.

6) Distribution - Solid set spraying (buried) is assumed for estimating distribution costs.

7) Distribution Pumping - Distribution pumping requirements are based on providing 45 psi at peak flow conditions. Pumping power costs are estimated based on 1990 average flows.

8) Monitoring Wells - A requirement of five monitoring wells is assumed for costing smaller systems, eight for larger systems. Wells are assumed to be twenty feet deep.

9) Service roads and fencing - These costs are based on total acreage of the spray field as presented in Costs of Wastewater Treatment by Land Application, EPA-430/9-75-003.

Costs associated with pre-application treatment of wastewaters for spray irrigation systems are determined by costing methods used for developing costs for wastewater treatment facilities. Secondary treatment is the assumed pre-treatment requirement.

An example of estimating land and storage requirements is presented in Table AIII-6. A complete cost development for a spray irrigation system is provided in Table AIII-7.

Wastewater Collection and Conveyance Facilities

Conventional Systems

Costs for conventional wastewater conveyance facilities include costs for pumping stations, gravity collection sewers, gravity intercepters, and force mains. The location and layout of these facilities are primarily dependent on site topography and population disaggregation. Capacities of collection and conveyance facilities used in costing for this study are based in year 2000 peak wastewater flow projections.

Construction costs for gravity collection lines and intercepter

TABLE AIII-6

SPRAY IRRIGATION LAND AND STORAGE REQUIREMENTS
0.5 mgd Staging Area - Park City Seasonal System

Assumptions: Spray irrigation used only during dry months of the year.

Application rate of 3 inches/week

Seven (7) days storage at peak seasonal flows required

Cave City Site "B" is the spray site

1. Volume storage required

7 days x 0.5 mgd = 3.5 mg
(projected peak season flow)

2. Land area required

3.5 mg/wk. = 468,000 cu. ft./wk.

@ 3 inch depth 1 acre = 10,895 cu. ft.

Estimated land required assuming 90% of land used. $= \frac{468{,}000 \text{ cu. ft.}}{10{,}895 \text{ cu. ft./acre}} \times \frac{1}{0.9} = 47.7$ acres

Estimated land required including 100 ft. buffer = 54.4 acres

Estimated land required for storage = 2 acres

Total estimated land required = 56.4 acres

TABLE AIII-7
EXAMPLE: SPRAY IRRIGATION COST DEVELOPMENT
0.5 mgd STAGING AREA - CAVE CITY SEASONAL SYSTEM

Spray Irrigation System Component	Independent Variable For Using Cost Curves(1)	Estimated Construction Costs	Estimated Annual* O&M Costs
Storage (3.5 mg lined, earthen basin)	Storage Volume (Figure 22, p.61)	$ 75,000*	$ 600
Field Preparation (grass and brush clearing)	Spray Site Acreage (Figure 24, p.85)	$ 1,400	-
Distribution (buried, solid set spraying)	Spray Site Acreage (Figure 27, p.91)	$135,000	$ 4,400
Distribution Pumping (construction cost)	Firm Pumping Capacity (peak design flow) (Figure 33, p.103)	$203,000	-
Distribution Pumping (O&M)	Design Average Flow (Figure 33, p.103)	-	$ 3,100
Transmission Force Main (8" force main)	Linear Feet (Figure 20, p.77)	$ 29,000	negligible
Transmission Pumping (construction cost)	Firm Pumping Capacity (peak design flow) (Figure 21, p.79	$231,000*	-
Transmission Pumping (O&M costs)	Design Average Flow (Figure 21, p.79	-	$ 2,100*
Monitoring Wells (8 wells, 20 ft. depth)	Number and Depth of Wells (Figure 40, p.117)	$ 8,	$ 1,400
Service Roads and Fencing	Site Acreage (Figure 41, p.118)	$ 65,000	$ 1,100
	TOTAL...	$747,500	$12,700
	Updated January 1981 TOTAL***	**$852,000**	**$14,500*****

Project Costs Estimation:

Estimated Construction Costs	$ 748,000
Engineering, Legal, Administration (30%)	$ 224,000
SUBTOTAL	$ 972,000
Estimated Land Costs	$ 67,000
Legal, Financial, Contingencies (12%)	$ 8,000
TOTAL PROJECT COSTS	$1,047,000

Updated January 1981 TOTAL PROJECT COSTS*.........$1,194,000**

(1) Costs of Wastewater Treatment by Land Application, EPA-430/9-75-003, Technical Report, USEPA, Washington, D.C., June, 1976.

* Includes additional 15% for site improvements.

** Since the spray irrigation system is only to be used seasonally, cost curve O&M estimates for some system components are adjusted to reflect seasonal usage. Labor costs for the distribution system, distribution pumping and transmission are assumed to be 0.67 of the annual estimate. Power costs for transmission and distribution pumping are based on five months pumping at the average 1990 flow.

*** Updated January 1981 Costs = Estimated June 1979 Cost x 1.14

and force mains are estimated using Davis-Bacon labor rates for federally funded projects in Barren and Hart Counties (Federal Register Vol. 43, No. 232 - Friday, December 1, 1978) and detailed bid prices (updated to June 1979) for similar recent construction projects. Construction cost estimates ($/linear foot) used for developing conveyance cost estimates are provided in Table AIII-8. Linear foot cost estimates are for pipe installation (in place costs) and include allowances for clearing, excavation (including rock), backfilling, repaving, special conditions and crossings, and manholes. These unit construction cost estimates were confirmed by Clifford Construction of Elizabethtown, Kentucky as being similar (+/- 10%) to costs they have experienced in the Mammoth Cave area. Project costs for gravity sewer and force mains are determined as follows:

Estimated Construction Costs ($/L.F. x L.F. Pipe)
Engineering, Legal, Administrative (25% of construction costs)
+ Financial (5% of construction costs)
Total Project Costs

Operation and maintenance costs estimates for collection and conveyance piping are based on unit O & M costs developed for the Metro Wheeling and Ohio Urban Study Wastewater Management Investigation Draft Report Appendix F, U.S. Corps of Engineers, Pittsburgh District, March 1978. Costs are updated to June 1979 using the EPA sewer cost index. Unit O & M cost estimates used for the Mammoth Cave area are as follows: *( ) indicates January 1981 cost estimates

Gravity	Unit O&M Cost	Force Main	Unit O&M Costs
8"	$480/mile (550)*	4"	$300/mile (340)
10"	$600/mile (680)	6"	$335/mile (380)
12"	$660/mile (750)	8"	$360/mile (410)
15"	$960/mile (1090)	10"	$480/mile (550)
18"	$960/mile (1090)	12"	$600/mile (680)
		14"	$720/mile (820)

TABLE AIII-8

ESTIMATED AVERAGE UNIT PRICES ($/L.F.)* FOR SANITARY SEWER PIPE IN PLACE

EPA SEWER INDEX 327 (PROJECTED JUNE 1979)

	6" Service Connection	8"	10"	12"	15"/15"	18"RCP	6"F.M.**	8"F.M.**	12"F.M.**	14"F.M.**
Pipe placed in highway right-of-way	$18.40 ($21.00)***	$29.60 ($33.70)	$33.85 ($38.60)	$37.70 ($43.00)	$42.20 ($48.10)	$46.70 ($53.20)	$16.12 ($18.40)	$17.40 ($19.80)	$26.30 ($30.00)	$28.30 ($32.30)
Pipe placed in streets	$25.10 ($28.60)***	$36.60 ($41.70)	$41.10 ($46.90)	$45.40 ($51.80)	$51.40 ($58.60)	$56.50 ($64.40)	$22.80 ($26.00)	$24.30 ($27.70)	$34.00 ($38.80)	$36.30 ($41.38)

* - Price includes allowances for clearing, excavation (including rock), backfilling, repaving, special conditions and crossings, and manholes.

** - Ductile Iron Pipe CL50

*** - ( ) indicates January 1981 Updated Costs = June 1979 costs x 1.14

Pumping station construction costs are determined using the cost curve from Benje's EPA document for pre-fabricated raw wastewater pumping stations. Project costs are developed in a manner similar to wastewater treatment facilities as follows:

Pump Station Cost (Equipment and installation)
Site Improvements (15% of Pump Station Costs)
Subtotal Construction Costs

Construction Costs
Engineering, Legal, Administrative Costs (25% of construction)
Interest during construction (5% of construction)
Total Project Costs

Pump station annual operation and maintenance costs are determined using supply and labor cost curves contained in the Benje's report as well as power requirements based on estimated pump horsepower and projected 1990 average wastewater flows. Labor and power costs estimated are based on $7 per man hour and $0.04 per KWH respectively.

A typical calculation of pumping station O & M costs is as follows:

Pumping Station: 0.37 mgd average design flow
1.48 mgd firm pumping capacity (design peak flow)
Cave City to Horse Cave

1. Labor costs (not flow related) = $1190/yr. Benjes Figure A-17 @ $7/mh
2. Supply costs (not flow related) = $400/yr. Benjes Figure A-18
3. Power Costs
   a. 32 hp required at peak design flow of 1.48 mgd
   b. Assuming peaking factor of 4, average design horsepower = 32/4 = 8 hp.
   c. Since power is flow related, use projected 1990 flows to estimate average power requirements for the planning period.

$$\text{Average required hp} = \frac{.24 \text{ mgd (avg. 1990)}}{.37 \text{ mgd (avg. design flow)}} \times 8 \text{ hp} = 5.2 \text{ hp}$$

$$\text{Annual power} = 5.2 \text{ hp} \times \frac{24 \text{ hrs.}}{\text{day}} \times 365 \frac{\text{days}}{\text{year}} \times .746 \frac{\text{KWH}}{\text{HP-Hour}}$$

$$= 33980 \text{ KWH/yr}$$

@ 4¢/KWH = $1360/yr.

4. Total Pumping Station O & M = $1190 + $400 + $1360 = $2950/yr.

Updated January = $3,360/yr.
1981 costs

Low Pressure Sewer Systems

Because there are relatively few low pressure sewer systems in operation, cost data is limited. Cost estimates for low pressure sewer systems used in this study are developed from cost information from the following sources:

1. Alternatives for Small Wastewater Treatment Systems Pressure Sewers/Vacuum Sewers, EPA Technology Transfer, EPA-625/4-77-011.

2. Milnes, T. R. and Smith, N., "Community Action at Quaker Lake: A Low Pressure System with Aerated Lagoons", Water Pollution Control Association of Pennsylvania Magazine, November-December, 1978.

3. "Lake Heritage, Pennsylvania-Collection System Feasibility Study prepared by Gannett Fleming Corddry and Carpenter, Inc., February 15, 1977.

4. Sparta Township, New Jersey Low Pressure Collection System Detailed construction cost estimates prepared by Gannett Fleming Corddry and Carpenter, Inc., completed March, 1977.

Costs for construction of low pressure sewers are obtained primarily from the cited projects and are based on linear footage of low pressure sewer line and number of connections. Grinder pump costs are determined using detailed estimates for the Sparta Project as well as actual costs for the Quaker Lake project. Construction costs for STEP systems as well as all O & M costs are based on the prices cited in the EPA technology transfer.

Unit cost estimates for developing low pressure sewer system costs are as follows:

System Component	Unit Cost	Annual O&M Costs
Lower pressure sewer line (2½" avg. diameter)	$8.40/LF ($9.60)**	$0.025/LF ($0.029)
House connections (laterals, etc.)	$3.50/ ($4.00) connection	-
Grinder Pumps (installed)	$2,700/pump ($3,080)	*$80/pump ($91)
STEP system (installed, including septic tank)	$2,000/ ($2,300) connection	*$80/connection ($91)
STEP system (installed with existing septic tank)	$1,500/ (1,700) connection	*$80/connection ($91)

*Includes power costs, 10 year overhaul, service calls and septic tank cleaning (STEP system).

** ( ) indicates January 1981 cost update

On-Lot Disposal Systems

An important treatment/disposal option considered for the unsewered areas of Munfordville and for the municipality of Park City is the use of individual conventional and alternate on-lot disposal systems. Conventional on-lot systems consist of the standard septic and soil absorption field and are used where soils are suitable. Alternate on-lot systems are used in areas where soils are marginally suitable or unsuitable for conventional systems and generally consist of a septic tank with some type of alternate-type absorption field such as an elevated sand mound or subsurface sand filter. Costs for the on-lot options for Park City and Munfordville are developed below.

Park City

There are approximately 240 residential/commercial water customers in Park City (Environmental Inventory Task Report). According to the Barren County Health Department, approximately 20 percent of the residences have properly constructed septic tank/soil absorption systems. It is assumed, therefore, that there are 195 water customers that require new on-lot disposal systems. However, density of development in the business section of Park City appears to be too high to accommodate individual on-lot soil absorption fields. Based on inspection of USGS maps, it is estimated that this area includes approximately 75 residences and commercial establishments. For the Park City on-lot option this area will be served by a STEP (Septic Tank Effluent Pumping) low pressure sewer system that will transport the septic tank effluents to a conventional community soil absorption field. The 120 water customers without adequate wastewater disposal systems that are not located in this area are to be served by individual on-lot disposal systems. For the purposes of costing this option, it is assumed that 55 are to be alternate systems and 65 are to be conventional (based on general inspection of Park City population distribution and area soils). Given these assumptions, the total 1980 construction project associated with this option includes the following:

55 alternate on-lot systems

65 conventional on-lot systems

75 STEP systems (see conveyance cost development)

Low pressure sewer (see conveyance cost development)

Community soil absorption field to serve 75 customers

Costs for on-lot systems are developed as follows:

Individual On-Lot Systems

Cost	Individual Conventional On-Lot Systems	Individual Alternate On-Lot Systems	Source
Construction Cost	$1,500 ($1,700)***	$4,000($4,600)	COWAMP*
Annual O&M Costs	$ 55 ($63)	$ 60($68)	COWAMP and Additional Estimates**

*COWAMP - Pennsylvania Comprehensive Water Quality and Management Plan.

**Additional estimates based on 1) Pumping septic tank every two years at $50/yr. = $25/yr. ($29)
2) Major repairs to soil absorption system every 10 years at $400 = $30/yr. ($34)

*** ( ) Indicates January 1981 Updated Cost = 1979 cost x 1.14

Community Soil Absorption Field

Construction Cost Item	Unit Costs
Soil Absorption Trench	$1.25/sq. ft. ($1.40) trench bottom (based on unit costs for individual systems)
Dosing Siphons	$1,000 EA. ($1,400)
Land Costs	$1,500/acre ($1,710)

Operation and maintenance costs for the community absorption system are estimated to be $3,100/yr.,($3,500) assuming 1 man day per week to check the distribution system at $60/man-day ($68)

Additional on-lot systems construction is anticipated as population increases in Park City. Assuming the number of disposal systems increases at the same rate as population, approximately 95 new disposal systems are to be constructed during the planning period. It is further assumed that 80 of these will be individual on-lot systems (40 conventional, 40 alternate on-lot) and 15 will be part of the STEP system. For cost purposes, the construction of the 80 additional individual on-lot systems is assumed to occur in 1991. Therefore, the 1991 construction costs and annual O & M costs from 1991 to 2000 are discounted to 1979 values and are part of the total present worth. The cost of the additional 15 STEP systems are included in the original STEP system construction costs.

A determination of project and annual O & M costs for the Park City on-lot option is provided in Table AIII-9.

Munfordville

Munfordville on-lot cost estimates are developed by a similar approach as that used in developing Park City costs. Since additional septic tank construction is expected to occur in low density residential areas, all additional systems are considered to be individual on-lot (i.e. no community system is required). On-lot system costs estimated for Munfordville are presented in Table AIII-10.

Waterless Composting Toilets

The cost estimate for waterless composting toilets to serve the Staging Area is based on information and design assumptions obtained

TABLE AIII-9
DETERMINATION OF COSTS FOR PARK CITY ON-LOT OPTION

	Quantity	Unit Cost	Construction Cost	Project Costs*	Annual O&M Costs
New Conventional Individual On-Lot Systems	65 EA	$1,500 ($1,700)***	$ 98,000 (112,000)	$ 98,000 (112,000)	$6,200** (7,000)
New Alternate Individual On-Lot Systems	55 EA	$4,000 (4,600)	$220,000 (251,000	$220,000 (251,000)	$3,300 (3,800)
Low Pressure Sewer System	See conveyance system development		$ 90,000 (103,000)	$117,000 (133,000)	$ 600 (680)
Step System (90 units)	90 EA	$2,000 (2,300)	$180,000 (205,000)	$234,000 (267,000)	$8,000 (9,100)
Community Absorption Field			$224,000 (255,000)	$292,000 (333,000)	$3,100 (3,500)
Installation of tile field	116,000 ft^2	$1.25/sq ft $1.40	$145,000 (165,000)		
Installation of dosing siphons	50 EA	$1,000 (1,100)	$ 50,000 (57,000)		
Land Costs	11 acres	$1,500/acre (1,700)	$ 16,500 (18,800)	$ 19,000 (21,700)	--
Present Worth Costs Associated with Additional On-Lot System Construction (1991)	80 EA	--	--	$116,000 (132,000)	$1,600 (1,800)

*Individual on-lot systems construction costs include all engineering etc.; project costs = construction costs

Step System and Community and Soil Absorption System

Construction Costs
+ 30 percent (engineering, legal, administrative)
Project Costs

**Includes O&M for "existing" 48 on-lot systems
***( ) Indicates January 1981 updated cost = 1979 cost estimate x 1.14

TABLE AIII-10
MUNFORDVILLE ON-LOT SYSTEMS COST ESTIMATES

COST ITEMS	QUANTITY	$/UNIT	COST	
Construction Costs				
New Conventional Systems	120	$ 1,500	$180,000	
New Alternate On-lot Systems	80	$ 4,000	$320,000	
1991 Conventional Systems	70	$ 790	$ 55,300	
1991 Alternate On-lot Systems	60	$ 2,106	$126,360	
		Total P.W....	$681,660 ($776,000)*	
O&M Costs (Including existing systems not replaced)				
Conventional Systems	270	$55/home	$ 14,850	1981-1991
Alternate Systems	80	$60/home	$ 4,800	
			$ 19,650	Avg. Total O&M 1981-1990≈$23,400 (26,000)
Conventional Systems	340	$55/home	$ 18,700	1991-2000
Alternate Systems	140	$60/home	$ 8,400	
			$ 26,100	

Back-Up & Assumptions

1978 There are presently approximately 600 water customers and about 250-300 sewer customers ∴ Say 350 existing water connections are in septic tanks. Assume replacement of 200 of these systems in 1979.

Assuming new development occurs outside the sewer area, new water customers are estimated using population projects.

Year 2000 water customers $\approx \left(\frac{\text{2000 population projection}}{\text{1978 population projection}} \times \text{1978 connections}\right) - \text{1978 connections}$

$\approx \left(\frac{2040}{1680} \times 600 \text{ connections}\right) - 600$

$\approx$ 128; Say 130

* ( ) indicates costs updated to January 1981

from Clivus Multrum U.S.A., Inc., a manufacturer of waterless composting toilets.

Assumptions:

(1) Estimated usage 10-12,000 uses/day during peak months of July and August.

(2) Toilets needed: 100 for women, 50 for men and 25 urinals.

(3) Estimated "greywater" (hand washwater) generated: 10-12,000 gallons/day during peak season.

Equipment Based on Use of Clivus Multrum System:

-100 tanks -- two midsections each.
-150 toilets (standard fixtures).
-25 urinals.
-Central exhaust fan piping.
-2 central exhaust fans.

Approximate Purchase Cost: $198,500; say $200,000

Annual Maintenance and Operating Expenses:

-For removal of fully composted materials from tanks--less than 100 person-hours/year (No other maintenance specific to the Clivus Multrum system is necessary.)
-Energy consumption: 2 ½-h.p. fans - total energy usage 750 watts/hr. - 18 k h/day. (Note: you would probably incur similar exhaust fan requirements for ventilating the lavatory facilities using any waste disposal system.)

Greywater Treatment System (10,000 gal./day)

-Pressure irrigation system for hand washwater.
-Distribution pipe system for leach field of 10,000 sq. ft.
-Roughing filter.
-Pump (gravity system without pump may be possible, dependent on topography.

Approximate Purchase Cost: $22,500 (does not include installation).

Annual Maintenance and Operating Expenses:

-Maintenance required: none.
-Energy consumption: 1 pump (if needed) - electrical consumption 750 watts/hour - 18 kWh/day.

Total Greywater Treatment System Costs

Purchase price of treatment system		$22,500
Construction cost of leach field ($10,000 x $1.25/sq. ft.)		12,500
Additional installation costs:	pump	1,000*
	roughing filter	2,000
	Subtotal	38,000
30% (Engineering, legal, administrative)		11,400
Total Greywater Project Cost		$49,400
	Say	$50,000

*costs for installing grinder pumps

Project Costs for Proposed Waterless Composting Toilet System

$200,000	purchase cost of waterless composting toilets
$ 50,000	project costs of greywater treatment system
$250,000	Total Project Costs
$285,000	January, 1981 Updated Cost (1979 cost x 1.14)

*Only purchase cost is considered since additional installation and construction costs are assumed to be comparable with conventional restroom facilities. (Waterless composting toilets provide both restroom and treatment facilities.)

Operation and Maintenance Costs

Only operation and maintenance requirements considered to exceed regular restroom maintnenace are considered.

Labor - 1/2 man-year @ $7.50/hr. plus benefits = $10,000/yr.
Power - 36 KWH/day x .04¢/KWH x 365 days/yr. = $525.60/yr.
Supplies - none in addition to regular restroom supplies -

Total $10,525/yr.
Say $11,000/yr.
$13,000/yr. Updated January 1981 cost (1979 cost x 1.14)

Wastewater Facilities Cost Evaluation

Present Worth Analysis (Completely updated to reflect January 1981 costs, 7.125 percent discount rate and the 1983-2000, 17-year design period)

The U.S. EPA guidelines require that the alternative conveyance and treatment systems be evaluated on a present worth and/or equivalent annual cost basis over the duration of the planning period in order to compare all alternatives on an equal basis. Costs to be considered include all capital costs for implementing a given project as well as the operation and maintenance costs needed to adequately ensure effective and dependable facility operation at the design treatment level. Where facilities are scheduled to function beyond the end of the planning period, a credit is given for salvage values.

These salvage values account for those system components that are normally expected to function beyond the 17-year planning period (1983-2000) and are used for cost analysis. Salvage values are generally considered as a percentage of the initial construction costs. The estimated salvage values for the various types of conveyance and treatment system components of the various alternatives are summarized in Table AIII-11. The assumptions regarding their depreciation is provided in the accompanying Table AIII-12. These percentages are based on assumed straight-line depreciation of facilities constructed during the planning period. It is assumed that existing facilities will have a "zero" salvage value at the end of the planning period. Therefore, for treatment plant upgrading alternatives, only the additional treatment units are considered.

As indicated in Table AIII-12 most facilities have two general cost components that determine salvage value, equipment and structures. Since structures are expected to function longer than equipment, they have a greater salvage value at the end of the planning period. The total salvage value for a facility having more than one cost component equals the sum of the salvage values of each of the components. The salvage value of each component is based on the estimated percentage of construction cost attributed to that component and its expected life.

TABLE AIII-11
YEAR 2000 - ESTIMATED SALVAGE VALUE AS A PERCENTAGE OF INITIAL CONSTRUCTION COSTS

	YEAR OF CONSTRUCTION		
TYPE OF FACILITY	1981	1983	1991
Conveyance	62 %	66 %	82 %
Wastewater Treatment Facilities			
Equipment	2.5 %	7.5 %	27.5 %
Structures	26.25%	28.75%	38.75%
Total	28.75%	36.25%	66.25%
Pumping Stations			
Equipment	1.66%	4.95%	18.26%
Structures	35.01%	38.53%	51.68%
Total	36.67%	43.48%	69.94%
Spray Irrigation Distribution Piping or Septic Tank Absorption Fields	5 %	15 %	55 %
Roads and Fencing for Spray Irrigation	52.5 %	57.5 %	77.5 %
Conventional Septic Tank and Soil Absorption System			
Septic Tank	17.5 %	19 %	25.83%
Absorption Field	3.3 %	10 %	36.30%
Total	20.8 %	29 %	62.13%
Alternate Septic Tank and Soil Absorption System			
Septic Tank	6.5 %	7.2 %	9.56%
Alternate Absorption System	4.3 %	13.1 %	47.3 %
Total	10.8 %	20.3 %	56.86%
STEP Systems for Low Pressure Sewers			
Structures	28.88%	31.63%	42.45%
Pump: Electrical	2.25%	6.75%	24.75%
Total	31.13%	38.38%	67.20%
Grinder Pumps for Low Pressure Sewers			
Grinder Pump	3.35%	10 %	36.85%
Structures	17.5 %	19 %	25.80%
Total	20.85%	29 %	62.65%

For example, one-half of treatment plant construction costs is considered to be for equipment and one-half for structures. However, structures are estimated to function for 40 years while equipment only 20 years. Therefore, the year 2000 salvage value of a wastewater treatment plant constructed in 1983 is estimated as follows:

Equipment Salvage Value = 1/2 x (initial construction costs)
x 3/20 = .075 (initial construction cost)

Structural Salvage Value = 1/2 x (initial construction costs)
x 23/40 = .2875 (initial construction cost)

Total Salvage Value = .3625,(Initial Construction Cost)

The revised present worth cost analysis for wastewater facilities is based on projected January 1981 price levels, a 17-year planning period ending in 2000, and an interest rate of 7.125 percent which is the current federal discount rate to be used for the evaluation of water and related land resources projects.

In developing present worth costs, two cost components are considered, those associated and with design and construction of facilities, and those attributed to annual operation and maintenance costs. Costs associated with design and construction are termed project costs and include construction costs, engineering, legal and administrative fees and interest during construction, as previously noted. Operation and maintenance costs include labor, supply and power costs. The total present worth estimate is determined as follows:

*Project Costs (Initial project costs plus the present worth of
any project costs resulting from construction
planned for later in the planning period)
+ Present Worth of estimated average annual O & M payments during
the planning period
Total Present Worth

*Project costs and O & M costs may also result from construction of wastewater facilities during the planning period after 1981. Only two treatment options include later construction, those involving on-lot systems in Park City and Munfordville. Construction is assumed for 1991, and project costs in that year are discounted to 1981 to obtain total project costs for the option. Likewise, O & M from 1991 to 2000 from this construction is annualized over the entire planning period, and included in the annual O&M costs.

A present worth value of annual operation and maintenance costs is determined based on the interest rate of 7.125 percent and the 17-year planning. The present worth value of a 17-year series of equal annual payments at this interest rate is 9.680, times the annual payments. Annual operation and maintenance costs for all the system components are assumed to be constant throughout the period, since flow-related operation and maintenance costs, with the exception of power costs, are not considered to significantly affect the total operation and maintenance costs. Power costs for treatment facilities and pump stations are based on 1990-1991 projected average daily flows. Since this is the mid-point of the planning period, these power costs are assumed to be adequate for providing an estimate of average annual power costs during the planning period. By combining average annual power costs, and annual labor and supply costs based on design capacity, average annual operation and maintenance costs are estimated for each system component. Present worth values of annual O & M costs are developed as follows:

9.680 (present worth factor, i = 7.125% t = 17 years) x Average Annual O & M Costs = Present Worth O & M Costs.

The net present worth accounts for the salvage value of facilities constructed as part of the project. The net present worth is the difference of total present worth and the salvage value as indicated below.

Total Present Worth
- Present Worth of the Year 2000 Salvage Value
Net Present Worth

A sample net present worth calculation is presented in Table AIII-13.

Local Annual Costs

The local annual cost analysis is a method by which the economic impact on the local population is examined. The local annual cost is determined using the total project costs and deducting the expected federal grant, leaving the local share.* This local share of project costs is converted into an annual debt service by a debt service factor 0.1033 representing 7.125 percent interest for the planning period (17 years). Although for purposes of this costing it is assumed that all capital costs are recovered by the end of the planning period, annual debt service may be slightly less if longer term bonds are purchased.

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*The expected federal grant is determined by deducting approximately 5 percent of construction costs (estimated ineligible costs such as interest during construction, rights-of-way, etc.) from the total project costs to obtain estimated grant eligible costs. The expected federal grant is 75 percent of the grant eligible costs except in the case of spray irrigation and on-lot systems which are assumed to be eligible for an 85 percent grant for pretreatment and land application components.

TABLE AIII-13 EXAMPLE: NET PRESENT WORTH COST DEVELOPMENT
JOINT TREATMENT/DISPOSAL OPTION (CC-HC) 1
January 1981 Updated Costs

System Component	(1) Construction Costs	(2) Project Costs	(3) Annual O&M Costs	(4) (9.68*xCol.3) Present Worth Annual Costs	(5) (Col. 2 + Col. 4) Total Present Worth	(6) Yr. 2000 Salvage Value	(7) (0.3104**xCol.6) Present Worth Salvage Value	(8) (Col.5-Col.7) Net Present Worth
Improvements for optimum use of Cave City WWTP	$ 112,000	$ 128,000	$ 44,000	$ 426,000	$ 552,000	$ 41,000	$ 13,000	$ 539,000
0.37 mgd Pumping facilities @ Cave City	137,000	177,000	3,400	33,000	210,000	60,000	19,000	191,000
12" Force Main CC-HC	440,000	572,000	1,900	18,000	590,000	290,000	90,000	500,000
16" Gravity Sewer CC-HC	327,000	425,000	1,400	14,000	439,000	216,000	67,000	372,000
Improvements for optimum use of Horse Cave WWTP	448,000	561,000	62,000	600,000	1,161,000	162,000	50,000	1,111,000
0.9 mgd joint secondary treatment step	897,000	1,165,000	47,000	455,000	1,620,000	325,000	101,000	1,519,000
20" Gravity Outfall from HC Treatment Site to downstream of East-South Hidden River Cave Confluence	342,000	445,000	1,000	9,700	455,000	226,000	70,000	385,000
TOTAL	$2,703,000	$3,473,000	$161,000	$1,556,000	$5,027,000	$1,320,000	$410,000	$4,617,000

*Present Worth Factor for 17 equivalent annual payments @ 7.125%
**Present Worth Factor for a year 2000 value @ 7.125%

For example, if the capital recovery period is 25 years instead of 17 years, annual debt service will be reduced by about 16 percent. To determine annual local costs, the annual debt service is added to the estimated average operation and maintenance costs during the planning period. An example calculation of annual local costs is provided in Table AIII-14.

Annual local costs for each population center for the eight wastewater management alternatives is presented in Table III-13 of the Alternatives Evaluation Technical Reference Document. As mentioned in the text, it is assumed that each population center involved in joint treatment/disposal will pay a percentage of local annual costs (based on estimated design flows) for only those wastewater facilities that handle its wastewater. An example calculation of breakdown of local annual costs is presented in Table AIII-15.

TABLE AIII-14 EXAMPLE: CALCULATION OF ANNUAL LOCAL COSTS
LOCAL TREATMENT/DISPOSAL OPTION HC-4

Cost Item	(1) Construction Costs	(2) Project Costs	(3) Grant Eligible Costs	(4) Expected Federal Grant (0.75(3))	(5) Local Share Project Costs ((2)-(4))	(6) Annual Debt Service (0.1033 (5))	(7) Annual O&M Costs	(8) Local Annual Costs (nearest $1,000) ((6)+(7))
Upgrade Horse Cave WWTP to provide secondary treatment	583,000	732,000	693,000	520,000	212,000	22,000	78,000	100,000
Industrial Force Main and Pump Station	190,000	247,000	233,000	175,000	72,000	7,400	1,800	9,000
0.53 mgd Pump Station (1.73 mgd peak flow)	160,000	207,000	196,000	147,000	60,000	6,200	6,000	12,000
12" Force Main Horse Cave to Green River	839,000	1,092,000	1,033,000	775,000	317,000	32,700	4,300	37,000

TOTAL LOCAL ANNUAL COSTS $158,000

TABLE AIII-15
EXAMPLE: CALCULATION OF LOCAL ANNUAL COST BY POPULATION CENTER
WASTEWATER MANAGEMENT ALTERNATIVE NO. 1 ((SA-PC-CC-HC) 1, MN-1)

Wastewater Facilities Cost Item	Staging Area*		Park City		Cave City		Horse Cave		Munfordville		Annual Cost Associated With Facilities
	Percent Design Flow	Annual Cost	Percent Design Flow	Annual Cost	Percent Design Flow	Annual Cost	Percent Design Flow	Annual Cost	Percent Design Flow	Annual Cost	
8" Gravity intercepter SA-PC	100	$ 82,000	0	-	0	-	0	-	0	-	$ 82,000
Park City collection system	0	-	100	$ 69,000	0	-	0	-	0	-	$ 69,000
0.16 mgd extended aeration facility @ Park City	50	$ 49,000	50	$ 27,000	0	-	0	-	0	-	$ 76,000
0.16 mgd P.S. at Park City	50	$ 6,600	50	$ 3,000	0	-	0	-	0	-	$ 9,600
Force Main PC-CC	50	$ 38,000	50	$ 11,000	0	-	0	-	0	-	$ 49,000
Gravity intercepter PC-CC	50	$ 24,000	50	$ 6,500	0	-	0	-	0	-	$ 30,500
Upgrading Cave City WWTP (.37 mgd)	0	-	0	-	100	$ 78,000	0	-	0	-	$ 78,000
0.53 mgd P.S. at Cave City	15	$ 4,200	15	$ 1,500	70	$ 8,000	0	-	0	-	$ 13,700
Force Main CC-HC	15	$ 9,300	15	$ 3,000	70	$ 13,000	0	-	0	-	$ 25,300
Gravity intercepter CC-HC	15	$ 7,500	15	$ 2,500	70	$ 11,000	0	-	0	-	$ 21,000
Upgrading Horse Cave WWTP (.53 mgd)	0	-	0	-	0	-	100	$111,000	0	-	$111,00
1.06 mgd P.S. at Horse Cave	7.5	$ 4,200	7.5	$ 1,500	35	$ 8,000	50	$ 11,000	0	-	$ 24,700
1.06 mgd force main HC-Green River	7.5	$ 9,400	7.5	$ 3,000	35	$ 13,000	50	$ 19,000	0	-	$ 44,400
Munfordville on-lot systems	0	-	0	-	0	-	0	-	100	$56,000	$ 56,000
TOTAL (nearest $1,000)		$234,000		$128,000		$131,000		$141,000		$56,000	$690,000

*Federal facilities are not eligible for EPA construction grants if they contribute more than 5% of the total flow. (EPA PRM 75-35 Dec. 29, 1978.) These are local costs for the National Park Service providing 100% of their share of the project costs.

PART B. SELECTION OF RECOMMENDED LOCAL AND JOINT WASTEWATER TREATMENT/DISPOSAL OPTIONS: COST-EFFECTIVENESS ANALYSIS

SELECTION OF RECOMMENDED LOCAL AND JOINT WASTEWATER TREATMENT/DISPOSAL OPTIONS COST EFFECTIVENESS ANALYSIS

Introduction

As discussed in the Alternatives Evaluation Technical Reference Document, a cost effectiveness analysis provides a method for gauging the "resources costs" of a particular alternative since it accounts for factors in addition to monetary costs. The four evaluation factors used in cost-effectiveness analyses in the Mammoth Cave Area EIS include monetary costs (net present worth), environmental impacts (natural and man-made environments), implementability and operability. These terms are explained in the text, pages III-52 to III-53.

The evaluation and selection of cost-effective local and joint wastewater treatment/disposal options for incorporation into the wastewater management alternatives involves performing an abbreviated cost effectiveness analysis for each set of local and joint treatment/disposal options. There are ten (10) sets of options to be evaluated as indicated below.

Option Set Identification	Options
PC	PC-1, PC-2
CC	CC-1, CC-2, CC-3
HC	HC-1, HC-2, HC-3, HC-4
MN	MN-1, MN-2
(SA-PC-CC-HC)	(SA-PC-CC-HC) 1, 2 & 3
(PC-SA-CC-HC)	(PC-SA-CC-HC) 1, 2 & 3
(PC-CC-HC)	(PC-CC-HC) 1, 2 & 3
(SA-CC-HC)	(SA-CC-HC) 1, 2 & 3
(CC-HC)	(CC-HC) 1, 2, 3, 4, 5, 6, 7 & 8
(PC-CC)	(PC-CC) 1, 2 & 3

Total No. Option Sets for Cost Effectiveness Analysis = 10

Total No. Options = 34

Note: Only one method of treatment/disposal is considered for the Staging Area (SA) and for the joint treatment disposal configuration (SA-CC). Therefore these are not among the sets of options requiring cost effectiveness analysis.

The cost-effectiveness analysis used for the evaluation and selection of local and joint wastewater treatment options is termed abbreviated because only monetary costs, natural environmental impacts and operability are evaluated quantitatively. Implementability and impacts on the man-made environment are not evaluated quantitatively. This is because, in most cases, these evaluation factors appear to be of little significance in selecting a treatment/disposal option within a given set. However, for those situations in which these factors do appear to be significant in the option selection, they are evaluated qualitatively.

The cost-effectiveness analysis for each set of options involves two steps:

1. Developing numerical scores for each option with respect to monetary costs (net present worth), operability and impacts in the natural environment.

2. Developing a cost-effectiveness rating for each option based on the scores of the evaluation factors and the relative importance of each.

The methodology used for establishing numerical scores for the evaluation factors is described in the Alternatives Evaluation Technical Reference Document. The methodology used for combining the scores on a common base to establish a cost effectiveness rating for each option is described in this section.

Cost Effectiveness Rating Methodology

Each local and joint wastewater treatment/disposal option is given a potential of 1000 cost effective rating points. A breakdown of these points according to evaluation factor is provided below:

Net Present Worth Costs	350
Impacts on the Natural Environment	400
Operability	100

This breakdown reflects a weighting of the relative importance of each factor as determined by an interdisciplinary team familiar with the Mammoth Cave area project. A total of only 850 out of 1000 points is assigned to these factors in order to allow for some latitude in option selection in cases where impacts on the man-made environment or implementability are considered significant. Cost-effectiveness ratings for all the local and joint wastewater treatment/ disposal options are presented in Table AIII-16.

Cost Evaluation*

The present worth analysis establishes a total cost value of the capital expenditures and annual operating costs of each alternative over the duration of the 19-year planning period (ending in the year 2000) using an interest rate of 6.875 percent. The net present worth analyses for local and joint wastewater treatment and disposal options are provided in Tables AIII-17 and AIII-18 respectively. In order to relate net present worth costs (dollars) to the rating point range, a rating function is developed for each set of options to inversely relate project costs to the rating points. This results in higher points for lower priced alternatives. The function is developed to match the midpoint in the range of costs with the midpoint in the range

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* This is the original 1979 cost evaluation. Costs are not updated to January 1981 since these cost evaluations are used to select local and joint treatment options to be included in the eight wastewater management alternatives and cost updating will not affect the selection.

TABLE AIII-16

ABBREVIATED COST-EFFECTIVENESS RATING
LOCAL AND JOINT WASTEWATER TREATMENT/DISPOSAL OPTIONS

Option Set	Option	Net Present Worth (350)	Environmental Impacts (natural environment) (400)	Capability (100)	Total
(SA-PC-CC-HC)	(SA-PC-CC-HC) 1	156	264	45	465
	(SA-PC-CC-HC) 2	199	269	46	514
	(SA-PC-CC-HC) 3	158	261	54	473
(PC-SA-CC-HC)	(PC-SA-CC-HC) 1	160	274	45	479
	(PC-SA-CC-HC) 2	193	282	46	521
	(PC-SA-CC-HC) 3	160	270	54	484
(PC-CC-HC)	(PC-CC-HC) 1	157	258	45	460
	(PC-CC-HC) 2	159	254	54	467
	(PC-CC-HC) 3	198	261	46	505
(SA-CC-HC)	(SA-CC-HC) 1	159	254	45	458
	(SA-CC-HC) 2	162	250	54	466
	(SA-CC-HC) 3	194	258	46	498
(CC-HC)	(CC-HC) 1	208	232	52	492
	(CC-HC) 2	151	252	38	441
	(CC-HC) 3	162	258	54	474
	(CC-HC) 4	195	233	62	490
	(CC-HC) 5	153	244	52	449
	(CC-HC) 6	165	249	58	472
	(CC-HC) 7	163	255	44	462
	(CC-HC) 8	178	261	52	491
(PC-CC)	(PC-CC) 1	158	249	40	447
	(PC-CC) 2	196	241	47	484
	(PC-CC) 3	176	241	60	477
CC	CC-1	172	238	55	485
	CC-2	161	240	42	443
	CC-3	191	238	45	474
HC	HC-1	187	254	48	489
	HC-2	164	258	41	463
	HC-3	174	254	59	487
	HC-4	169	262	53	484
PC	PC-1	128	226	54	408
	PC-2	276	222	46	544
MN	MN-1	318	196	45	559
	MN-2	120	203	54	377

TABLE AIII-17 LOCAL TREATMENT/DISPOSAL OPTIONS

NET PRESENT WORTH ANALYSIS

Option Identification	Description	1981 Project Cost	Annual O & M Costs	Present Worth O & M Costs	Total Present Worth	Year 2000 Salvage Value	Present Worth Salvage Value	Net Present Worth
MN-1	No collection system expansion; individual on-lot systems.	$ 681,000	$23,000	$242,000	$ 923,000	$ 281,000	$ 80,000	$ 843,000
MN-2	Expansion of collection system w/LP sewers; upgrading existing Munfordville Wastewater Treatment Plant.	2,066,000	35,000	366,000	2,432,000	715,000	203,000	2,229,000
HC-1	Upgrade Horse Cave Wastewater Treatment Plant to provide advanced secondary treatment (Class I reliability); discharge to Hidden River Cave.	1,637,000	82,000	861,000	2,499,000	463,000	131,000	2,368,000
HC-2	Upgrade Horse Cave Wastewater Treatment Plant to provide secondary treatment (Class III reliability); seasonal spray irrigation.	2,365,000	84,000	875,000	3,240,000	775,000	219,000	3,021,000 (2,693,000)*
HC-3	New oxidation ditch to provide advanced secondary treatment (Class I reliability); discharge to Hidden River Cave.	1,849,000	81,000	843,000	2,693,000	529,000	149,000	2,544,000
HC-4	Upgrade Horse Cave Wastewater Treatment Plant to provide secondary treatment (Class III reliability); discharge to Green River.	1,998,000	79,000	821,000	2,819,000	713,000	201,000	2,618,000

*This net present worth represents cost preference value for spray irrigation required for cost comparison by EPA Cost-Effectiveness Guidelines (40 CFR 35, subpart A.7.a).
(Cost preference value = Actual NPW/1.15)

TABLE AIII-17 (Continued)

Option Identification	Description	1981 Project Cost	Annual O & M Costs	Present Worth O & M Costs	Total Present Worth	Year 2000 Salvage Value	Present Worth Salvage Value	Net Present Worth
CC-1	New 0.37 mgd oxidation ditch (Class I reliability); discharge to subsurface.	$1,111,000	$54,000	$563,000	$1,674,000	$ 246,000	$ 69,000	$1,605,000
CC-2	Upgrade existing Cave City Wastewater Treatment Plant to secondary treatment (Class III reliability); seasonal spray irrigation.	1,141,000	65,000	683,000	2,094,000	454,000	128,000	1,966,000 (1,710,000)*
CC-3	Upgrade existing Cave City Wastewater Treatment Plant to advanced secondary treatment (Class I reliability); discharge to subsurface.	866,000	60,000	626,000	1,492,000	180,000	51,000	1,441,000
PC-1	Gravity collection system; 0.08 mgd extended aeration package plant; spray irrigation.	2,831,000	34,300	358,000	3,189,000	1,242,000	351,000	2,838,000 (2,683,000)*
PC-2	Individual on-lot systems; LP sewer; community soil absorption systems.	1,096,000	23,000	237,000	1,333,000	314,000	90,000	1,243,000
SA-1	Composting toilets; greywater treatment system.	250,000	15,000	156,000	406,000	108,000	31,000	375,000

*This net present worth represents cost preference value for spray irrigation required for cost comparison by EPA Cost-Effectiveness Guidelines (40 CFR 35, subpart A.7.a).
(Cost preference value = Actual NPW/1.15)

TABLE AIII-18 JOINT TREATMENT/DISPOSAL OPTIONS
NET PRESENT WORTH ANALYSIS

Option Identification	Description	1981 Project Cost	Annual O & M Costs	Present Worth O & M Costs	Total Present Worth	Year 2000 Salvage Value	Present Worth Salvage Value	Total Option Net Present Worth	Net Present Worth Associated With Option Differences
(SA-PC-CC-HC) 1	Optimum treatment at existing Horse Cave and Cave City plants; joint secondary treatment step at Horse Cave; discharge to Green River.	$8,517,000	$205,000	$2,135,000	$10,652,000	$3,442,000	$ 973,000	$ 9,679,000	$3,001,000
(SA-PC-CC-HC) 2	Upgrade existing Horse Cave and Cave City facilities to secondary treatment (Class III reliability); discharge to Green River.	8,078,000	182,300	1,902,000	9,980,000	3,304,000	934,000	9,047,000	2,349,000
(SA-PC-CC-HC) 3	Abandon existing Horse Cave and Cave City plant; joint secondary treatment at new 1.06 mgd oxidation ditch at Horse Cave; discharge to Green River.	8,787,000	177,100	1,847,000	10,634,000	3,473,000	997,000	9,637,000	2,959,000
(PC-SA-CC-HC) 1	Optimum treatment at existing Horse Cave and Cave City plants; joint secondary treatment step at Horse Cave; discharge to Green River.	8,942,000	222,000	2,316,000	11,257,000	3,650,000	1,032,000	10,225,000	3,001,000
(PC-SA-CC-HC) 2	Upgrade existing Horse Cave and Cave City facilities to secondary treatment (Class III reliability); discharge to Green River.	8,594,000	206,000	2,146,000	10,689,000	3,526,000	997,000	9,692,000	2,497,000
(PC-SA-CC-HC) 3	Abandon existing Horse Cave and Cave City plants; joint secondary treatment at new 1.11 mgd oxidation ditch at Horse Cave, discharge to Green River.	9,250,000	197,000	2,049,000	11,298,000	3,746,000	1,059,000	10,239,000	3,015,000

TABLE AIII-18 (Continued)

Option Identification	Description	1981 Project Cost	Annual O & M Costs	Present Worth O & M Costs	Total Present Worth	Year 2000 Salvage Value	Present Worth Salvage Value	Total Option Net Present Worth	Net Present Worth Associated With Option Differences
(PC-CC-HC) 1	Optimum treatment at existing Horse Cave and Cave City plants; joint secondary treatment step at Horse Cave, discharge to Green River.	$7,220,000	$190,000	$1,982,000	$8,989,000	$2,943,000	$ 832,000	$8,157,000	$2,945,000
(PC-CC-HC) 2	Abandon existing Horse Cave and Cave City plant; joint secondary treatment at new 0.98 mgd oxidation ditch at Horse Cave, discharge to Green River.	7,475,000	163,000	1,701,000	9,176,000	3,774,000	1,067,000	8,109,000	2,897,000
(PC-CC-HC) 3	Upgrade existing Horse Cave and Cave City facilities to secondary treatment (Class III reliability); discharge to Green River.	6,792,000	170,000	1,774,000	8,566,000	2,803,000	792,000	7,774,000	2,324,000
(SA-CC-HC) 1	Optimum treatment at existing Horse Cave and Cave City plants; joint secondary treatment step at Horse Cave; discharge to Green River.	6,512,000	192,000	2,005,000	8,517,000	2,448,000	692,000	7,825,000	2,972,000
(SA-CC-HC) 2	Abandon existing Horse Cave and Cave City plants; joint secondary treatment at new 1.11 mgd oxidation ditch at Horse Cave, discharge to Green River.	6,773,000	165,000	1,720,000	8,493,000	2,533,000	716,000	7,777,000	2,927,000
(SA-CC-HC) 3	Upgrade existing Horse Cave and Cave City facilities to secondary treatment (Class III reliability); discharge to Green River.	6,144,000	175,000	1,821,000	7,965,000	2,388,000	675,000	7,290,000	2,440,000

TABLE AIII-18 (Continued)

Option Identification	Description	1981 Project Cost	Annual O & M Costs	Present Worth O & M Costs	Total Present Worth	Year 2000 Salvage Value	Present Worth Salvage Value	Total Option Net Present Worth	Net Present Worth Associated With Option Differences
(CC-HC) 1	Optimum treatment at existing Horse Cave and Cave City plants; joint secondary treatment step at Horse Cave; discharge to Hidden River Cave.	$3,047,000	$141,000	$1,469,000	$4,516,000	$ 987,000	$279,000	$4,237,000	$3,449,000
(CC-HC) 2	Same as (CC-HC) 1 with seasonal spray irrigation system.	4,871,000	164,600	1,717,000	6,588,000	1,662,000	470,000	4,118,000 (5,557,000)*	5,330,000 (4,769,000)*
(CC-HC) 3	Same as (CC-HC) 1 with discharge to Green River.	4,018,000	152,000	1,589,000	5,607,000	1,383,000	391,000	5,216,000	4,428,000
(CC-HC) 4	Conversion of Cave City plant to a pumping station; joint advanced secondary treatment (Class I reliability); 0.9 mgd oxidation ditch wastewater treatment plant at Horse Cave; discharge to Hidden River Cave.	3,613,000	113,000	1,177,000	4,790,000	1,461,000	322,000	4,468,000	3,680,000
(CC-HC) 5	Conversion of Cave City plant to pumping station; joint secondary treatment (Class III reliability); .9 mgd oxidation ditch wastewater treatment plant at Horse Cave; seasonal spray irrigation.	5,116,000	140,000	1,459,000	6,575,000	1,864,000	527,000	6,048,000 (5,474,000)*	5,260,000 (4,686,000)*
(CC-HC) 6	Same as (CC-HC) 5 with discharge to the Green River.	4,263,000	124,200	1,297,000	5,560,000	1,464,000	414,000	5,146,000	4,358,000
(CC-HC) 7	Upgrade existing Horse Cave and Cave City plants to secondary treatment (Class III reliability); seasonal spray irrigation at Horse Cave.	4,568,000	153,000	1,596,000	6,164,000	1,485,000	420,000	5,744,000 (5,193,000)*	4,956,000 (4,405,000)*

*This net present worth represents cost preference value for spray irrigation required for cost comparison by EPA Cost-Effectiveness Guidelines (40 CFR 35, subpart A.7.a).
(Cost preference value = Actual NPW/1.15)

TABLE AIII-18 (Continued)

Option Identification	Description	1981 Project Cost	Annual O & M Costs	Present Worth O & M Costs	Total Present Worth	Year 2000 Salvage Value	Present Worth Salvage Value	Total Option Net Present Worth	Net Present Worth Associated With Option Differences
(CC-HC) 8	Same as (CC-HC) 7 with discharge to Green River.	$3,715,000	$141,000	$1,470,000	$5,185,000	$1,343,000	$379,000	$4,806,000	$4,018,000
(SA-CC)	Upgrade existing Cave City Wastewater Treatment Plant to provide joint secondary treatment (Class III reliability); for Rt. 70 and Cave City wastewaters; seasonal spray irrigation.	3,685,000	95,000	991,000	4,676,000	1,443,000	408,000	4,416,000 (4,080,000)*	-
(PC-CC) 1	Upgrade existing Cave City Wastewater Treatment Plant to provide secondary treatment (Class III reliability); combine with treated Park City wastewater for seasonal spray irrigation.	4,591,000	96,000	1,000,000	5,591,000	2,002,000	566,000	5,025,000 (4,701,000)*	2,059,000 (1,791,000)*
(PC-CC) 2	Upgrade existing Cave City Wastewater Treatment Plant to provide advanced secondary treatment (Class I reliability); combine with treated Park City wastewater for discharge to the subsurface.	3,943,000	89,000	928,000	4,871,000	1,637,000	463,000	4,407,000	1,441,000
(PC-CC) 3	Abandon existing Cave City Wastewater Treatment Plant and construct new oxidation ditch plant to provide advanced secondary treatment (Class I reliability); combine with Park City wastewater for discharge to the subsurface.	4,188,000	83,000	866,000	5,054,000	1,708,000	483,000	4,571,000	1,605,000

*This net present worth represents cost preference value for spray irrigation required for cost comparison by EPA Cost-Effectiveness Guidelines (40 CFR 35, subpart A.7.a).
(Cost preference value = Actual NPW/1.15)

of rating points. This approach results in the following general function for establishing the net present worth rating for each option:

$$\text{Present Worth Rating} = \frac{(\text{Midpoint in the cost range for the set of options (dollars)}) \times 175}{\text{Option Present Worth (dollars)}}$$

Example Rating Determination

Option Set: HC
Options: HC-1, HC-2, HC-3, HC-4
Highest net present worth: $2,693,000 (HC-2)
Lowest net present worth: $2,368,000 (HC-1)
Mid-point: $2,530,500

$$\text{Present Worth Rating for HC Option Set} = \frac{\$2{,}530{,}500\ (175)}{\text{Option Present Worth}}$$

$$\text{Therefore: HC-4 Present Worth Rating} = \frac{\$2{,}530{,}500\ (175)}{\$2{,}618{,}000} \cong 193$$

Tables AIII-19 and AIII-20 present the net present worth ratings for all the local and joint treatment disposal options, respectively. The net present worth ratings for joint treatment disposal options are based only on the net present worth costs associated with the differences in the options, not the total net present worth of the option. This is because the joint options within a given set have many common cost items. (i.e. the features that account for the differences in the options only represent a portion of the total option costs.) Comparing the total option estimated net present worth does not provide a true picture of the relative cost differences of the options.

For example, the differences in treatment/disposal options (SA-PC-CC-HC)1, 2 & 3 are associated only with the handling of treatment of Cave City and Horse Cave wastewaters, which account for only approximately one-third of the total option costs. The net present worth ratings developed by using the two methods are as follows:

TABLE AIII-19 NET PRESENT WORTH RATINGS
LOCAL OPTIONS

Option Set	Option	Net Present Worth	Net Present Worth Rating
MN	MN-1	$ 843,000	318
	MN-2	$2,229,000	120
HC	HC-1	$2,368,000	187
	HC-2	$2,693,000	164
	HC-3	$2,544,000	174
	HC-4	$2,618,000	169
CC	CC-1	$1,605,000	172
	CC-2	$1,710,000	161
	CC-3	$1,441,000	191
PC	PC-1	$2,683,000	128
	PC-2	$1,243,000	276

TABLE AIII-20 NET PRESENT WORTH RATINGS JOINT TREATMENT/DISPOSAL OPTIONS

Option Set	Option	Net Present Worth Associated With Option Differences	Net Present Worth Ratings
(SA-PC-CC-HC)	(SA-PC-CC-HC)1	$3,001,000	156
	(SA-PC-CC-HC)2	$2,349,000	199
	(SA-PC-CC-HC)3	$2,959,000	158
(PC-SA-CC-HC)	(PC-SA-CC-HC)1	$3,001,000	160
	(PC-SA-CC-HC)2	$2,497,000	193
	(PC-SA-CC-HC)3	$3,015,000	160
(PC-CC-HC)	(PC-CC-HC)1	$2,945,000	157
	(PC-CC-HC)2	$2,897,000	159
	(PC-CC-HC)3	$2,324,000	198
(SA-CC-HC)	(SA-CC-HC)1	$2,972,000	159
	(SA-CC-HC)2	$2,927,000	162
	(SA-CC-HC)3	$2,440,000	194
(PC-CC)	(PC-CC)1	$1,791,000	158
	(PC-CC)2	$1,441,000	196
	(PC-CC)3	$1,605,000	176
(CC-HC)	(CC-HC)1	$3,449,000	208
	(CC-HC)2	$4,769,000	151
	(CC-HC)3	$4,428,000	162
	(CC-HC)4	$3,680,000	195
	(CC-HC)5	$4,686,000	153
	(CC-HC)6	$4,358,000	165
	(CC-HC)7	$4,405,000	163
	(CC-HC)8	$4,018,000	178

Option	Total Option Net Present Worth	Rating	Net Present Worth Associated With Option Differences	Rating
(SA-PC-CC-HC) 1	$9,699,000	169	3,001,000	156
(SA-PC-CC-HC) 2	$9,047,000	181	2,349,000	199
(SA-PC-CC-HC) 3	$9,657,000	170	2,959,000	158

Note: Net present worth associated with costs common to each option = $6,698,000.

This illustrates that if only costs associated with the option differences are considered, the relative difference in net present worth ratings is substantially increased. This provides a more appropriate method for cost comparison and rating of joint options.

Environmental Impacts Evaluation (Natural Environment)

Impacts on the natural environment resulting from wastewater treatment and disposal practices is one of the primary concerns of the Mammoth Cave Area EIS. Accordingly, this evaluation factor is worth 400 points in the cost effectiveness rating, the highest value given to any factor.

A parameter-checklist evaluation methodology is used for the evaluation of impacts to the natural environment for local and joint wastewater treatment options. A complete discussion of the environmental impacts evaluation methodology is presented in the Alternatives Evaluation Technical Reference Document, pages III-60 to III-71. This includes discussion of the parameter-checklist evaluation methodology as well as the selection of parameters considered in the environmental impacts evaluation.

As described on pages III-61 and III-62, a scaling-weighting checklist is used in this project to evaluate potential impacts in the natural environment. Weights are assigned to each parameter to reflect its relative importance in the environmental evaluation. Scaling is accomplished by assigning rates for each parameter relative to the magnitude of the impact of a proposed action on that parameter. Rates and weights both have a numerical range of zero to four according to the following scheme:

0 = no importance/impact
1 = slight importance/impact
2 = moderate importance/impact
3 = significant importance impact
4 = highly significant importance impact

Rates may be either beneficial (+) or adverse (-). The score for a parameter-wastewater treatment/disposal option is the product of the weight and the rate:

$$(\text{Score})_{P-0} = (\text{Weight})_P \times (\text{Rate})_{P-0}$$

The summation of products for each parameter yields a total score for each option. Given the weights assigned to the parameters considered in this evaluation, the possible scores for any option range from -172 to +172. These raw scores must be adjusted to be incorporated into the positive 0-400 range assigned to environmental impacts in the cost-effectiveness analysis. By adding 172 to a raw score insures that all scores will have possitive values (≥0). The positive range is then 0-344. In order to adjust the positive range to the maximum available rating range, each score is multiplied by a factor to match the scores to the rating points. This results in the following rating function.

$$\text{Environmental Impacts Rating} = (\text{Impact Evaluation Raw Score} + 172)\ 1.16$$

The results of the environmental impacts evaluation (raw scores) for the local and joint wastewater treatment/disposal options are presented in Table AIII-21. The environmental ratings are presented in Table AIII-22.

The treatment and disposal options are organized into six option groups, for the purposes of this evaluation. The option groups are defined by the areas included in the group. Option Group 1 includes eight joint treatment/disposal options involving Cave City, Horse Cave, Park City and the Staging Area (SA-PC-CC-HC)1-4 and (PC-SA-CC-HC)1-4. Option Group 2 consists of three joint treatment/disposal options for Cave City, Horse Cave and the Staging Area. Option Group 3 presents three joint treatment/disposal options for Cave City, Horse Cave and Park City. Joint treatment/disposal options involving two population centers are included in Option Groups 4 (Cave City, Horse Cave) and 5 (Cave City, Park City). Option Group 6 consists of local treatment options for Cave City, Horse Cave, Munfordville and Park City. The environmental impacts evaluations are discussed below according to option group.

Option Group 1: Eight joint treatment/disposal options constitute Option Group 1. These options involve combining wastes from Park City, the Staging Area, Cave City and Horse Cave. Four of the options route the flow from the Staging Area to Park and then to the other towns along Rt. 31-W (Options (SA-PC-CC-HC)1-4). The remaining options involve pumping treated Park City wastewaters to the Staging Area and then routing the combined wastewaters along Rt. 70 (Options (PC-SA-CC-HC)1-4). The additional differences between options involve treatment facilities and facility location. All eight options include final discharge to the Green River near Lawler Bend.

TABLE AIII-21

ENVIRONMENTAL IMPACT EVALUATION (NATURAL ENVIRONMENT) RAW SCORES FOR TREATMENT AND DISPOSAL OPTIONS

Parameter	Option Treatment Discharge Pt. Weight	(SA-PC-CC-HC)1 Secondary Green River Rate	Score	(SA-PC-CC-HC)2 Secondary Green River Rate	Score	(SA-PC-CC-HC)3 Secondary Green River Rate	Score
Groundwater Quality:							
Free Flowing	4	4	16	4	16	4	16
Diffuse	3	3	9	3	9	2	6
Groundwater Quantity:							
Free Flowing	1	-2	-2	-2	-2	-2	-2
Diffuse	1	-1	-1	-1	-1	-1	-1
Groundwater Supplies	3	4	12	4	12	4	12
Surface Water:							
Quality	3	-1	-3	-1	-3	-1	-3
Quantity	1	1	1	1	1	1	1
Biology	3	-1	-3	-1	-3	-1	-3
Terrestrial Vegetation	2	-2	-4	-2	-4	-2	-4
Wildlife	2	-1	-2	-1	-2	-1	-2
Cave Biological Systems	4	3	12	3	12	3	12
Rare & Endangered Species	4	3	12	4	16	3	12
Sensitive Areas	4	3	12	4	12	3	12
Soils	2	-2	-4	-2	-4	-2	-4
Geology	2	0	0	0	0	0	0
Topography	1	-1	-1	-1	-1	-1	-1
Air Quality	1	-1	-1	-1	-1	-1	-1
Noise	1	-1	-1	-1	-1	-1	-1
Odor	1	4	4	4	4	4	4
TOTAL	43		56		60		53

TABLE AIII-21

ENVIRONMENTAL IMPACT EVALUATION (NATURAL ENVIRONMENT) RAW SCORES FOR TREATMENT AND DISPOSAL OPTIONS (Cont'd.)

Parameter	Option Treatment Discharge Pt. Weight	(PC-SA-CC-HC)1 Secondary Green River		(PC-SA-CC-HC)2 Secondary Green River		(PC-SA-CC-HC)3 Secondary Green River	
		Rate	Score	Rate	Score	Rate	Score
Groundwater Quality:							
Free Flowing	4	4	16	4	16	4	16
Diffuse	3	3	9	4	12	2	6
Groundwater Quantity:							
Free Flowing	1	-2	-2	-2	-2	-2	-2
Diffuse	1	-1	-1	-1	-1	-1	-1
Groundwater Supplies	3	4	12	4	12	4	12
Surface Water:							
Quality	3	-1	-3	-1	-3	-1	-3
Quantity	1	1	1	1	1	1	1
Biology	3	-1	-3	-1	-3	-1	-3
Terrestrial Vegetation	2	-2	-4	-2	-4	-2	-4
Wildlife	2	-1	-2	-1	-2	-1	-2
Cave Biological Systems	4	4	16	4	16	4	16
Rare & Endangered Species	4	3	12	4	16	3	12
Sensitive Areas	4	4	16	4	16	4	16
Soils	2	-2	-4	-2	-4	-2	-4
Geology	2	0	0	0	0	0	0
Topography	1	-1	-1	-1	-1	-1	-1
Air Quality	1	-1	-1	-1	-1	-1	-1
Noise	1	-1	-1	-1	-1	-1	-1
Odor	1	4	4	4	4	4	4
TOTAL	43		64		71		61

TABLE AIII-21

ENVIRONMENTAL IMPACT EVALUATION (NATURAL ENVIRONMENT) RAW SCORES FOR TREATMENT AND DISPOSAL OPTIONS

(Cont'd.)

Parameter	Option Treatment Discharge Pt. Weight	(SA-CC-HC)1 Secondary Green River		(SA-CC-HC)2 Secondary Green River		(SA-CC-HC)3 Secondary Green River		(PC-CC-HC)1 Secondary Green River	
		Rate	Score	Rate	Score	Rate	Score	Rate	Score
Groundwater Quality:									
Free Flowing	4	3	12	3	12	3	12	4	16
Diffuse	3	2	6	1	3	3	9	2	6
Groundwater Quantity:									
Free Flowing	1	-1	-1	-1	-1	-1	-1	-2	-2
Diffuse	1	-1	-1	-1	-1	-1	-1	-1	-1
Groundwater Supplies	3	3	9	3	9	3	9	3	9
Surface Water:									
Quality	3	-1	-3	-1	-3	-1	-3	-1	-3
Quantity	1	1	1	1	1	1	1	1	1
Biology	3	-1	-3	-1	-3	-1	-3	-1	-3
Terrestrial Vegetation	2	-2	-4	-2	-4	-2	-4	-2	-4
Wildlife	2	-1	-2	-1	-2	-1	-2	-1	-2
Cave Biological Systems	4	4	16	4	16	4	16	4	16
Rare & Endangered Species	4	3	12	3	12	3	12	3	12
Sensitive Areas	4	2	8	2	8	2	8	2	8
Soils	2	-2	-4	-2	-4	-2	-4	-2	-4
Geology	2	0	0	0	0	0	0	0	0
Topography	1	-1	-1	-1	-1	-1	-1	-1	-1
Air Quality	1	-1	-1	-1	-1	-1	-1	-1	-1
Noise	1	-1	-1	-1	-1	-1	-1	-1	-1
Odor	1	4	4	4	4	4	4	4	4
TOTAL	43		47		44		50		50

TABLE AIII-21

ENVIRONMENTAL IMPACT EVALUATION (NATURAL ENVIRONMENT) RAW SCORES FOR TREATMENT AND DISPOSAL OPTIONS (Cont'd.)

Parameter	Option Treatment Discharge Pt. Weight	(PC-CC-HC)2 Secondary Green River Rate	(PC-CC-HC)2 Secondary Green River Score	(PC-CC-HC)3 Secondary Green River Rate	(PC-CC-HC)3 Secondary Green River Score	(CC-HC)1 Secondary Cave Rate	(CC-HC)1 Secondary Cave Score	(CC-HC)2 Secondary Cave - Land Rate	(CC-HC)2 Secondary Cave - Land Score
Groundwater Quality:									
Free Flowing	4	4	16	4	16	1	4	3	12
Diffuse	3	1	3	2	6	0	0	-1	-3
Groundwater Quantity:									
Free Flowing	1	-2	-2	-2	-2	1	1	0	0
Diffuse	1	-1	-1	-1	-1	0	0	1	1
Groundwater Supplies	3	3	9	4	12	2	6	2	6
Surface Water:									
Quality	3	-1	-3	-1	-3	0	0	0	0
Quantity	1	1	1	1	1	0	0	0	0
Biology	3	-1	-3	-1	-3	0	0	0	0
Terrestrial Vegetation	2	-2	-4	-2	-4	-1	-2	-1	-2
Wildlife	2	-1	-2	-1	-2	0	0	0	0
Cave Biological Systems	4	4	16	4	16	2	8	3	12
Rare & Endangered Species	4	3	12	3	12	1	4	2	8
Sensitive Areas	4	2	8	2	8	2	8	3	12
Soils	2	-2	-4	-2	-4	-1	-2	-1	-2
Geology	2	0	0	0	0	0	0	0	0
Topography	1	-1	-1	-1	-1	0	0	0	0
Air Quality	1	-1	-1	-1	-1	-1	-1	-1	-1
Noise	1	-1	-1	-1	-1	-1	-1	-1	-1
Odor	1	4	4	4	4	3	3	3	3
TOTAL	43		47		53		28		45

TABLE AIII-21

ENVIRONMENTAL IMPACT EVALUATION (NATURAL ENVIRONMENT) RAW SCORES FOR TREATMENT AND DISPOSAL OPTIONS

(Cont'd.)

Parameter	Option Treatment Discharge Pt. Weight	(CC-HC)3 Secondary Green River		(CC-HC)4 Adv. Secondary Cave		(CC-HC)5 Secondary Cave-Land		(CC-HC)6 Secondary Green River	
		Rate	Score	Rate	Score	Rate	Score	Rate	Score
Groundwater Quality:									
Free Flowing	4	4	16	2	8	3	12	4	16
Diffuse	3	0	0	-1	-3	-2	-6	-1	-3
Groundwater Quantity:									
Free Flowing	1	1	1	1	1	0	0	1	1
Diffuse	1	0	0	0	0	1	1	0	0
Groundwater Supplies	3	3	9	2	6	2	6	3	9
Surface Water:									
Quality	3	-1	-3	0	0	0	0	-1	-3
Quantity	1	1	1	0	0	0	0	1	1
Biology	3	-1	-3	0	0	0	0	-1	-3
Terrestrial Vegetation	2	-1	-2	-1	-2	-1	-2	-1	-2
Wildlife	2	-1	-2	0	0	0	0	-1	-2
Cave Biological Systems	4	3	12	2	8	3	12	3	12
Rare & Endangered Species	4	3	12	1	4	2	8	3	12
Sensitive Areas	4	3	12	2	8	2	8	2	8
Soils	2	-2	-4	-1	-2	-1	-2	-2	-4
Geology	2	0	0	0	0	0	0	0	0
Topography	1	-1	-1	0	0	0	0	-1	-1
Air Quality	1	-1	-1	-1	-1	-1	-1	-1	-1
Noise	1	-1	-1	-1	-1	-1	-1	-1	-1
Odor	1	4	4	3	3	3	3	4	4
TOTAL	43		50		29		38		43

TABLE AIII-21

ENVIRONMENTAL IMPACT EVALUATION (NATURAL ENVIRONMENT) RAW SCORES FOR TREATMENT AND DISPOSAL OPTIONS
(Cont'd.)

Parameter	Option Treatment Discharge Pt. Weight	(CC-HC)7 Secondary Cave-Land Rate	(CC-HC)7 Secondary Cave-Land Score	(CC-HC)8 Secondary Green River Rate	(CC-HC)8 Secondary Green River Score	(PC-CC)1 Secondary Cave-Land Rate	(PC-CC)1 Secondary Cave-Land Score	(PC-CC)2 Adv. Secondary Cave Rate	(PC-CC)2 Adv. Secondary Cave Score
Groundwater Quality:									
Free Flowing	4	3	12	4	16	3	12	3	12
Diffuse	3	-1	-3	0	0	1	3	2	6
Groundwater Quantity:									
Free Flowing	1	0	0	1	1	-1	-1	1	1
Diffuse	1	1	1	0	0	1	1	-1	-1
Groundwater Supplies	3	3	9	4	12	2	6	2	6
Surface Water:									
Quality	3	0	0	-1	-3	0	0	0	0
Quantity	1	0	0	1	1	0	0	0	0
Biology	3	0	0	-1	-3	0	0	0	0
Terrestrial Vegetation	2	-1	-2	-1	-2	-1	-2	-1	2
Wildlife	2	0	0	-1	-2	0	0	0	0
Cave Biological Systems	4	3	12	3	12	3	12	2	8
Rare & Endangered Species	4	2	8	3	12	2	8	1	4
Sensitive Areas	4	3	12	3	12	2	8	1	4
Soils	2	-1	-2	-2	-4	-2	-4	-1	-2
Geology	2	0	0	0	0	0	0	0	0
Topography	1	0	0	-1	-1	0	0	0	0
Air Quality	1	-1	-1	-1	-1	-1	-1	-1	-1
Noise	1	-1	-1	-1	-1	-1	-1	-1	-1
Odor	1	3	3	4	4	2	2	2	2
TOTAL	43		48		53		43		36

TABLE AIII-21

ENVIRONMENTAL IMPACT EVALUATION (NATURAL ENVIRONMENT) RAW SCORES FOR TREATMENT AND DISPOSAL OPTIONS

(Cont'd.)

Parameter	Option Treatment Discharge Pt. Weight	(PC-CC)2 Adv. Secondary Cave		PC-3 Ext. Aeration Land		PC-2 Septic Tanks Subsurface		CC-1 Adv. Secondary Cave	
		Rate	Score	Rate	Score	Rate	Score	Rate	Score
Groundwater Quality:									
Free Flowing	4	3	12	2	8	1	4	3	12
Diffuse	3	2	6	1	3	1	3	0	0
Groundwater Quantity:									
Free Flowing	1	1	1	-1	-1	-1	-1	0	0
Diffuse	1	-1	-1	2	2	1	1	0	0
Groundwater Supplies	3	2	6	1	3	1	3	2	6
Surface Water:									
Quality	3	0	0	0	0	0	0	0	0
Quantity	1	0	0	0	0	0	0	0	0
Biology	3	0	0	0	0	0	0	0	0
Terrestrial Vegetation	2	-1	2	-1	-2	-1	-2	0	0
Wildlife	2	0	0	-1	-2	0	0	0	0
Cave Biological Systems	4	2	8	2	8	1	4	2	8
Rare & Endangered Species	4	1	4	1	4	1	4	1	4
Sensitive Areas	4	1	4	1	4	1	4	1	4
Soils	2	-1	-2	-1	-2	0	0	0	0
Geology	2	0	0	0	0	0	0	0	0
Topography	1	0	0	0	0	-1	-1	0	0
Air Quality	1	-1	-1	-1	-1	0	0	-1	-1
Noise	1	-1	-1	-2	-2	-1	-1	-1	-1
Odor	1	2	2	1	1	1	1	1	1
TOTAL	43		36		23		19		33

TABLE AIII-21

ENVIRONMENTAL IMPACT EVALUATION (NATURAL ENVIRONMENT) RAW SCORES FOR TREATMENT AND DISPOSAL OPTIONS (Cont'd.)

Parameter	Option Treatment Discharge Pt. Weight	CC-2 Secondary Cave-Land		CC-3 Adv. Secondary Cave		HC-1 Adv. Secondary Cave		HC-2 Secondary Cave-Land	
		Rate	Score	Rate	Score	Rate	Score	Rate	Score
Groundwater Quality:									
Free Flowing	4	3	12	3	12	3	12	3	12
Diffuse	3	-1	-3	0	0	0	0	-1	-3
Groundwater Quantity:									
Free Flowing	1	-2	-2	0	0	0	0	-1	-1
Diffuse	1	1	1	0	0	0	0	1	1
Groundwater Supplies	3	2	6	2	6	2	6	2	6
Surface Water:									
Quality	3	0	0	0	0	0	0	0	0
Quantity	1	0	0	0	0	0	0	0	0
Biology	3	0	0	0	0	0	0	0	0
Terrestrial Vegetation	2	0	0	0	0	0	0	0	0
Wildlife	2	0	0	0	0	0	0	0	0
Cave Biological Systems	4	3	12	2	8	2	8	3	12
Rare & Endangered Species	4	2	8	1	4	2	8	3	12
Sensitive Areas	4	1	4	1	4	3	12	3	12
Soils	2	-1	-2	0	0	0	0	-1	-2
Geology	2	0	0	0	0	0	0	0	0
Topography	1	0	0	0	0	0	0	0	0
Air Quality	1	-1	-1	-1	-1	-1	-1	-1	-1
Noise	1	-1	-1	-1	-1	-1	-1	-1	-1
Odor	1	1	1	1	1	3	3	3	3
TOTAL	43		35		33		47		50

TABLE AIII-21

ENVIRONMENTAL IMPACT EVALUATION (NATURAL ENVIRONMENT)
RAW SCORES FOR TREATMENT AND DISPOSAL OPTIONS
(Cont'd.)

Parameter	Option Treatment Discharge Pt. Weight	HC-3 Adv. Secondary Cave		HC-4 Secondary Green River		MN-1 Ext. Aeration Green River		MN-2 Ext. Aeration Green River	
		Rate	Score	Rate	Score	Rate	Score	Rate	Score
Groundwater Quality:									
Free Flowing	4	3	12	4	16	0	0	0	0
Diffuse	3	0	0	0	0	-1	-3	1	3
Groundwater Quantity:									
Free Flowing	1	0	0	-2	-2	0	0	0	0
Diffuse	1	0	0	0	0	0	0	0	0
Groundwater Supplies	3	2	6	2	6	0	0	0	0
Surface Water:									
Quality	3	0	0	-1	-3	0	0	0	0
Quantity	1	0	0	1	1	0	0	0	0
Biology	3	0	0	-1	-3	0	0	0	0
Terrestrial Vegetation	2	0	0	-1	-2	0	0	0	0
Wildlife	2	0	0	0	0	0	0	0	0
Cave Biological Systems	4	2	8	4	16	0	0	0	0
Rare & Endangered Species	4	2	8	3	12	0	0	0	0
Sensitive Areas	4	3	12	3	12	0	0	0	0
Soils	2	0	0	-1	-2	0	0	0	0
Geology	2	0	0	0	0	0	0	0	0
Topography	1	0	0	0	0	0	0	0	0
Air Quality	1	-1	-1	0	0	0	0	0	0
Noise	1	-1	-1	0	0	0	0	0	0
Odor	1	3	3	3	3	0	0	0	0
TOTAL	43		47		54		-3		3

TABLE AIII-22

LOCAL AND JOINT TREATMENT/DISPOSAL ENVIRONMENTAL IMPACTING RATING

Option Set	Option	Raw Score	Environmental Impacts Rating
(SA-PC-CC-HC)	(SA-PC-CC-HC)1	56	264
	(SA-PC-CC-HC)2	60	269
	(SA-PC-CC-HC)3	53	261
(PC-SA-CC-HC)	(PC-SA-CC-HC)1	64	274
	(PC-SA-CC-HC)2	71	282
	(PC-SA-CC-HC)3	61	270
(PC-CC-HC)	(PC-CC-HC)1	50	258
	(PC-CC-HC)2	47	254
	(PC-CC-HC)3	53	261
(SA-CC-HC)	(SA-CC-HC)1	47	254
	(SA-CC-HC)2	44	250
	(SA-CC-HC)3	50	258
(CC-HC)	(CC-HC)1	28	232
	(CC-HC)2	45	252
	(CC-HC)3	50	258
	(CC-HC)4	29	233
	(CC-HC)5	38	244
	(CC-HC)6	43	249
	(CC-HC)7	48	255
	(CC-HC)8	53	261
(PC-CC)	(PC-CC)1	43	249
	(PC-CC)2	36	241
	(PC-CC)3	36	241
CC	CC-1	33	238
	CC-2	35	240
	CC-3	33	238
HC	HC-1	47	254
	HC-2	50	258
	HC-3	47	254
	HC-4	54	262
PC	PC-1	23	226
	PC-2	19	222
MN	MN-1	-3	196
	MN-2	3	203

All eight options received identical rates and scores for several parameters, due to basic similarities among the options. Highly significant, beneficial impacts are predicted for free-flowing groundwater quality, groundwater supplies and odor, for all eight options. The complete removal of effluents from the area with final disposal to the Green River accounts for these ratings. Negative impacts to groundwater quantity were assessed as moderate for the free-flowing parameter and minor for the diffuse component. These effects would be produced by the change in disposal techniques from the groundwater component. This disposal option change also accounts for the minor negative impact to surface water quality and biology and the minor beneficial impact to surface water quantity. The extensive pipeline construction accounts for the moderate negative impacts on terrestrial vegetation and soils, and the minor negative impacts to topography, air quality and noise. Important differences in rates exist between options for the parameters of diffuse groundwater quality, cave biological systems, rare and endangered species and sensitive areas. These parameter-option combinations are all beneficial in nature but range from moderate to highly significant in degree. The diffuse groundwater quality exhibits the largest range in rates (2-4). This variation between option rating is due to the degree of treatment the wastes receive before piping. The ratings reflect the problems associated with potential pipeline leakage.

The (PC-SA-CC-HC) family of options produced a greater benefit (4) to the cave biological systems than the (SA-PC-CC-HC) group. The difference reflects the sewering of commercial development along Rt. 70. Of these two families of options, options (PC-SA-CC-HC)2 and (SA-PC-CC-HC)2, respectively, appear to be the most environmentally favorable, as indicated by the evaluation scores in Table AIII-22. This is primarily because these options provide for secondary treatment prior to effluent transport.

Option Group 2: This group includes three joint treatment/disposal options which transport wastewater from the Staging Area to Cave City and then to Horse Cave. Final effluent discharge is to the Green River. The three options differ only in the location and types of treatment facilities. The fundamental similarities in the options are reflected in nearly identical total environmental evaluation scores for the three (Table AIII-22). Beneficial impacts for all three options were rated as highly significant for cave biological systems and odor, significant for free-flowing groundwater quality, groundwater supplies and rare and endangered species and moderate for sensitive areas. Negative ratings ranged from moderate to slight. The three options are nearly equivalent with a minor difference being associated with the diffuse groundwater quality parameter. This difference reflects the degree of treatment prior to piping.

Option Group 3: The evaluation of the PC-CC-HC options is virtually identical to the SA-CC-HC (Alternative System 2) evaluations. The three options are nearly equivalent with minor differences being associated with treatment levels prior to piping and the siting of treatment facilities.

Option Group 4: This system includes eight joint treatment/disposal options which combine wastes from Cave City and Horse Cave. Treatment options vary in treatment degree and facility location. Disposal options include effluent discharge to the Green River ((CC-HC)3, (CC-HC)6 and (CC-HC)8), discharge to the Hidden River Cave system ((CC-HC)1 and (CC-HC)4) and a combination of discharge to the cave system and land application ((CC-HC)2, (CC-HC)5 and (CC-HC)7). These differences between options are reflected in the relatively wide ranges in option-parameter rates and the total environmental evaluation scores.

Overall, the most environmentally desirable option for Option Group 4 is (CC-HC) , which includes secondary treatment of Cave City wastewaters at Cave City, secondary treatment of Horse Cave wastewaters at Horse Cave, combining the effluents for joint disposal and discharge of the final effluent to the Green River. Highly significant beneficial impacts were assessed for (CC-HC)8 in the areas of free-flowing and diffuse groundwater quality and odor. Significant beneficial impacts include groundwater supplies, cave biological systems, rare and endangered species and sensitive areas. Moderate (soils) and minor (surface water quality, surface water biology, terrestrial vegetation, wildlife, topography, air quality, noise) negative impacts are primarily associated with construction activities and effluent disposal.

Option Group 5: This option group (PC-CC) includes three joint treatment/disposal options which vary in both degree of treatment and effluent disposal method. The options all include treatment of Park City wastewaters at Park City with transport of the effluent to Cave City, treatment in Cave City, and disposal in the Cave City area. (PC-CC)1 includes seasonal land disposal and discharge to the cave system. (PC-CC)2 and (PC-CC)3 both include discharge to the cave system but they differ in that (PC-CC)2 calls for upgrading the existing facility to provide advanced secondary treatment, while (PC-CC)3 calls for constructing a new treatment plant. (PC-CC)1 received the highest total environmental evaluation score of the three options. This is primarily due to the greater degree of protection given to the free-flowing groundwater quality, groundwater supplies, rare and endangered species and sensitive areas by the land application option.

Option Group 6: Local treatment and disposal options are grouped into Option Group 6. Options are evaluated for Park City, Cave City, Horse Cave and Munfordville. Local options are not evaluated for the Staging Area since there is only one method of wastewater treatment and disposal to be considered for local treatment/disposal.

The total environmental evaluation scores for the local treatment option indicate that the land disposal options for Park City (PC-2) and Cave City (CC-2), are the preferred alternatives based on environmental criteria. In both cases this evaluation is primarily due to relatively large beneficial impacts to the free flowing groundwater quality, cave biological systems and rare and endangered species parameters. Horse Cave option (HC-4) is preferred since discharge to Hidden River Cave is eliminated. The options for Munfordville involve the use of the existing extended aeration treatment system. MN-1 does not include a solids handling program or any extension of the current collection system. This would leave many areas of Munfordville on septic systems. MN-2 calls for extending the collection system and additional solids handling facilities at the existing plant. The environmental evaluation scores indicate that MN-2 is the preferred alternative based primarily on the reduction in septic field usage.

These analyses are incorporated into the overall evaluation of treatment and disposal options.

Operability Evaluation

For the Mammoth Cave Area EIS there are actually two operability evaluations. The first is an evaluation of wastewater treatment and disposal facilities for local and joint treatment/disposal options. The second is an evaluation of the wastewater facilities as well as service configurations for the wastewater management alternatives.

The first evaluation is primarily an operability evaluation of different types of wastewater treatment and disposal systems. This is because within each set of local or joint treatment/disposal options, methods of providing wastewater service are common to each option, with only treatment and disposal systems differing. However, the operability evaluation of the wastewater management alternatives must include consideration of not only the operability of the wastewater facilities but also the conveyance and management systems. This is especially true with respect to flexibility since for wastewater management alternatives consideration is given to the ability of the wastewater management alternative to accommodate future areas of development. This is not a consideration in evaluating treatment and disposal facilities only.

Criteria

The general evaluation criteria selected for determining operability ratings for wastewater facilities are summarized below in outline form. Additional criteria specific to the Mammoth Cave EIS wastewater management alternatives are included in the text of the Alternatives Evaluation Task Report, pages III-88 to III-89.

1. Reliability
    a. Lower wastewater treatment levels are more reliable than higher treatment levels.
    b. Multiple facilities are just as reliable as single facilities.
    c. Older facilities are not as reliable as new facilities.
    d. Spray irrigation of treatment plant effluent is less reliable than surface water discharge of effluent.
2. Flexibility
    a. There is no difference in flexibility among levels of treatment.
    b. Multiple facilities are more flexible than single (regional) facilities.

    c. New facilities are more flexible than older facilities.
    d. Spray irrigation of effluent is less flexible than surface discharge.

3. Maintainability
    a. Facilities with lower wastewater treatment levels are more maintainable than those with higher levels.
    b. Multiple facilities are less maintainable than single (regional) facilities.
    c. New facilities are more maintainable than older facilities.
    d. Treatment facilities with spray irrigation of effluent are just as maintainable as treatment facilities with surface discharges.

Evaluation Procedure

The evaluation procedure used for developing an operability rating for either a treatment/disposal option or a wastewater management alternative is the same. As described in the **Alternatives Evaluation Technical Reference Document a numerical rating system is developed which combines ratings for each of the operability factors (reliability, flexibility and maintainability) into a total operability score. The rating system provides for a maximum possible** operability score of 100 points. Flexibility, reliability and maintainability are weighted at thirty (30), forty (40) and thirty (30) points respectively, thus, indicating reliability to be the most significant factor. Using the applicable evaluation criteria, each operability factor is rated on a scale of 1 to 10, ten (10) being excellent and one (1) being poor. This rating is multiplied by the weighting proportion to determine the score. For example a reliability rating of 6, translates to a score of 24 $\left(\frac{6}{10} = \frac{24}{40}\right)$.

The total operability evaluation score is the sum of these operability factor scores.

The operability rating for the local and joint treatment option cost-effectiveness analysis is determined by first matching the midpoint of the evaluation scores for a set of options, to the midpoint of the rating points allotted for operability (i.e. midpoint of 100 = 50). The operability rating is calculated as follows:

$$\frac{50}{\text{Mid-point of evaluation scores for the option set}} \times \text{Option Operability Evaluation Score} = \text{Operability rating points}$$

Table AIII-23 presents a summary of operability evaluation scores and ratings for all the local and joint wastewater treatment/disposal options.

TABLE AIII-23

OPERABILITY RATINGS
LOCAL AND JOINT WASTEWATER TREATMENT/DISPOSAL OPTIONS

Alternative	Operability Evaluation Score	Operability Rating
(SA-PC-CC-HC)1	60	45
(SA-PC-CC-HC)2	61	46
(SA-PC-CC-HC)3	72	54
(PC-SA-CC-HC)1	60	45
(PC-SA-CC-HC)2	61	46
(PC-SA-CC-HC)3	72	54
(PC-CC-HC)1	60	45
(PC-CC-HC)2	72	54
(PC-CC-HC)3	61	46
(SA-CC-HC)1	60	45
(SA-CC-HC)2	72	54
(SA-CC-HC)3	61	46
(CC-HC)1	62	52
(CC-HC)2	46	38
(CC-HC)3	65	54
(CC-HC)4	74	62
(CC-HC)5	63	52
(CC-HC)6	69	58
(CC-HC)7	53	44
(CC-HC)8	63	52
(PC-CC)1	56	40
(PC-CC)2	66	47
(PC-CC)3	83	60
PC-1	66	54
PC-2	56	46
CC-1	74	55
CC-2	56	42
CC-3	60	45
HC-1	60	48
HC-2	52	41
HC-3	74	59
HC-4	67	53
MN-1	55	45
MN-2	66	54

PART C. COST COMPARISON: LOW PRESSURE SEWERS VS. CONVENTIONAL WASTEWATER COLLECTION SYSTEMS

LOW PRESSURE SEWERS VS. CONVENTIONAL COLLECTION SYSTEMS COST COMPARISONS

General Cost Assumptions

A. Low Pressure Sewers

General Cost Assumptions	Annual O&M Costs
Lower pressure sewer line $8.40/LF (2½" avg. diameter)	$.025/LF
House connections (laterals, etc.) $350/connection	-
Grinder Pumps (installed) $2,700/connection	$80/connection

B. Conventional Sewers

Capital Costs	Annual O&M Costs
12" gravity sewer - $45.40/LF	$0.125/LF
10" gravity sewer - $41.10/LF	$0.114/LF
8" gravity sewer - $36.60/LF	$0.091/LF
6" laterals - $25.10/LF	$0.086/LF
4" force main - $15.00/LF	$0.057/LF
Pump stations (Benjes' curves)	(see Benjes)

Cost Comparisons

A. Park City (Assume: 250 connections for 1981 construction
104 additional connections during the planning period)

1. Conventional collection system as proposed in the 201 plan:

1981 Construction Costs

Cost Item	Quantity	Estimated Construction Costs
12" gravity sewer	300 LF	13,600
10" gravity sewer	1,700 LF	69,900
8" gravity sewer	24,500	896,700
6" laterals (assume 50' per connection)	12,000	301,200
50 gpm pumping station	1	56,000
4" force main	1,600	24,000
	TOTAL	1,361,400

Project Costs ≅ 1.3 x construction costs ≅ 1,770,000

2. Low pressure sewer system construction costs (1981):

Cost Item	Quantity	Estimated Construction Costs
Low pressure sewer (Approx. 2½" diameter average)	27,800 LF*	$233,500
Grinder Pumps	250 connections	675,000
House connections (laterals, etc.)	250 connections	87,500
		996,000

Project Costs ≅ 1.3 construction costs ≅ $1,295,000

*Assume L.P. sewers follow 201 plan conventional sewer layout except for the 12" intercepter section.

3. Net present worth comparison: (See Table AIII-24.)

B. Munfordville (Assume: 325 connections for 1981 construction
130 additional connections during the planning period)

1. Conventional collection system additions as proposed by the 201 plan: (Table AIII-25.)

TABLE AIII-24 PARK CITY
CONVENTIONAL VS. LOW PRESSURE SEWER
NET PRESENT WORTH COST ANALYSIS

Project Costs	Annual O&M	Present Worth O&M	Salvage Value	Present Worth Salvage Value	Net Present Worth	Local Annual Costs
			Conventional			
$1,771,000	$ 5,400	$56,000	$839,000	$237,000	$1,590,000	$53,000
*$ 87,000	-	-	$107,000	$ 30,000	$ 37,000	$ 3,500
$1,858,000	$ 5,400	$56,000	$933,400	$267,000	$1,627,000	$56,500
			Low Pressure			
$1,295,000	$21,000	$219,000	$340,000	$ 96,000	$1,418,000	$54,900
*$ 212,000	**$ 3,000	$ 31,000	$206,000	$ 58,000	$ 185,000	$19,700
$1,507,000	$24,000	$250,000	$546,000	$154,000	$1,603,000	$74,600
						or
						$75,000
					with 85% grant	$43,000
						$19,700
						$63,000
					(estimated 5% for interest during construction-not grant eligible)	

*Present Worth 1991 Construction Costs - Assume additional connections are all constructed in 1991 (mid-point of the planning period).
104 new connections - 5,200 LF. 6" lateral connections (conventional) or
104 Grinder Pumps, etc. (Low Pressure)

**Includes O&M for grinder pumps installed in 1991 annualized over the entire planning period.
1991-2000 9 year P.W. = $8,320 (6.55) P/A = $54,500 (1991)
P.W. = $54,500 (.5143) P/F = $28,000 (1981)
Annual Cost = $28,000 (.09585) A/P = $2,686; say $3,000 (1980-2000)

TABLE AIII-25
MUNFORDVILLE CONVENTIONAL COLLECTION SYSTEM EXPANSION
1981 CONSTRUCTION PROJECT AND O&M COST ESTIMATES

Cost Item	Construction Cost	Project Cost	*Annual O&M Costs	Year 2000 Salvage Value
Existing Pump Station No. 2 - Change Impeller	$ 2,000	$ 2,000	-	-
Construct Pump Station A (150 gpm or .215 mgd)	$54,000	$70,000	$1,080	$14,000
Generator & Electrical Lines	$24,000	$24,000		$ 1,200
Construct Pump Station B (125 gmp or .18 mgd)	$54,000	$70,000	$1,032	$14,000
Construct Pump Station C (100 gpm or .144 mgd)	$54,000	$70,000	$1,000	$14,000
Generator & Electrical Lines	$36,500	$36,000	negligible	$ 1,800
Construct Pump Station D (75 gpm or .11 mgd)	$54,000	$70,000	$ 930	$14,000
6 inch Force Main (10,800 L.F.)	$246,000	$320,000	$ 600	$152,000
Connecting Existing 4" F.M. to 8" Gravity Line (200 L.F.)	$ 7,300	$ 9,500	-	$ 4,500
8" Gravity Sewer (4,000 L.F.)	$146,000	$190,000	$ 400	$ 90,000
8" Gravity Sewer (32,500 L.F.)	$1,190,000	$1,547,000	$3,000	$738,000
6" Pipe (9,000 L.F.)	226,000	$ 294,000	$ 400	$140,000
	$2,094,000	$2,702,000	$8,400	$1,183,000

*For pump station costs, assume 50'head pumping 6 hrs./day.

2. Low pressure sewer system construction costs (1981)

Cost Item	Quantity	Estimated Construction Costs
Low pressure sewer (Approx. 2½" diameter average)	*32,500	$273,000
Grinder Pumps	325	$878,000
House Connections (laterals, etc.)	325	$114,000
		TOTAL-$1,265,000

Project Costs ≅ 1.3 x Construction Costs ≅ $1,644,000.

*Assume length of L.P. sewer to be identical to the estimated length of 8" collection sewer in the 201 plan.

3. Net present worth comparison:
(See Table AIII-26.)

TABLE AIII-26 MUNFORDVILLE
CONVENTIONAL VS. LOW PRESSURE SEWER
NET PRESENT WORTH ANALYSIS

Project Costs	Annual O&M	Present Worth O&M	Yr. 2000 Salvage Value	Present Worth Salvage Value	Net Present Worth
			Conventional		
$2,702,000	$ 8,400	$ 88,000	$1,183,000	$334,000	$2,456,000
$ 109,000	-	-	$ 99,000	$ 25,000	$ 84,000
					$2,540,000
			Low Pressure		
$1,644,000	$27,000	$282,000	$ 423,000	$120,000	$1,806,000
$ 265,000	$ 4,000	$ 42,000	$ 257,000	$ 73,000	$ 234,000
$1,909,000					$2,040,000

Since Conventional is about 1/2 million greater - Choose Low Pressure.

*Present worth 1991 Construction Costs - Assume additional connections are all constructed in 1991 (mid-point of the planning period)
130 new connections - 6500 LF 6" x $25.10 = $163,000 (construction) ($109,000 P.W.)
or 130 grinder pumps, etc. = $396,000 (construction) ($265,000 P.W.)

Annual Costs for 325 connections by ratio with Park City connections = $\frac{325}{250} \times 21{,}000 \cong \$27{,}000$

P.W. 1991 Annual Costs
(again by ratio with Park City costs) $\frac{130}{104} \times \$3{,}000 = \$3{,}750$; say $4,000.

PART D. ALTERNATIVE ROUTING OF FORCE MAIN OUTFALL FROM HORSE CAVE TO THE GREEN RIVER

ROUTING OF FORCE MAIN OUTFALL FROM HORSE CAVE TO THE GREEN RIVER

Figure AIII-1 indicates the alternative force main routes proposed by the EIS and 201 plans. The EIS route is shorter than the 201 route, however, there is a 75 foot increase in static head that must be overcome by pumping. The analysis below compares the total dynamic heads (static plus friction head) as well as capital versus O&M costs for the two routes.

201 Plan: Approx. 44,000 feet of 14" force main

static head ≅ 20'

EIS: Approx. 28,000 feet of 14" force main

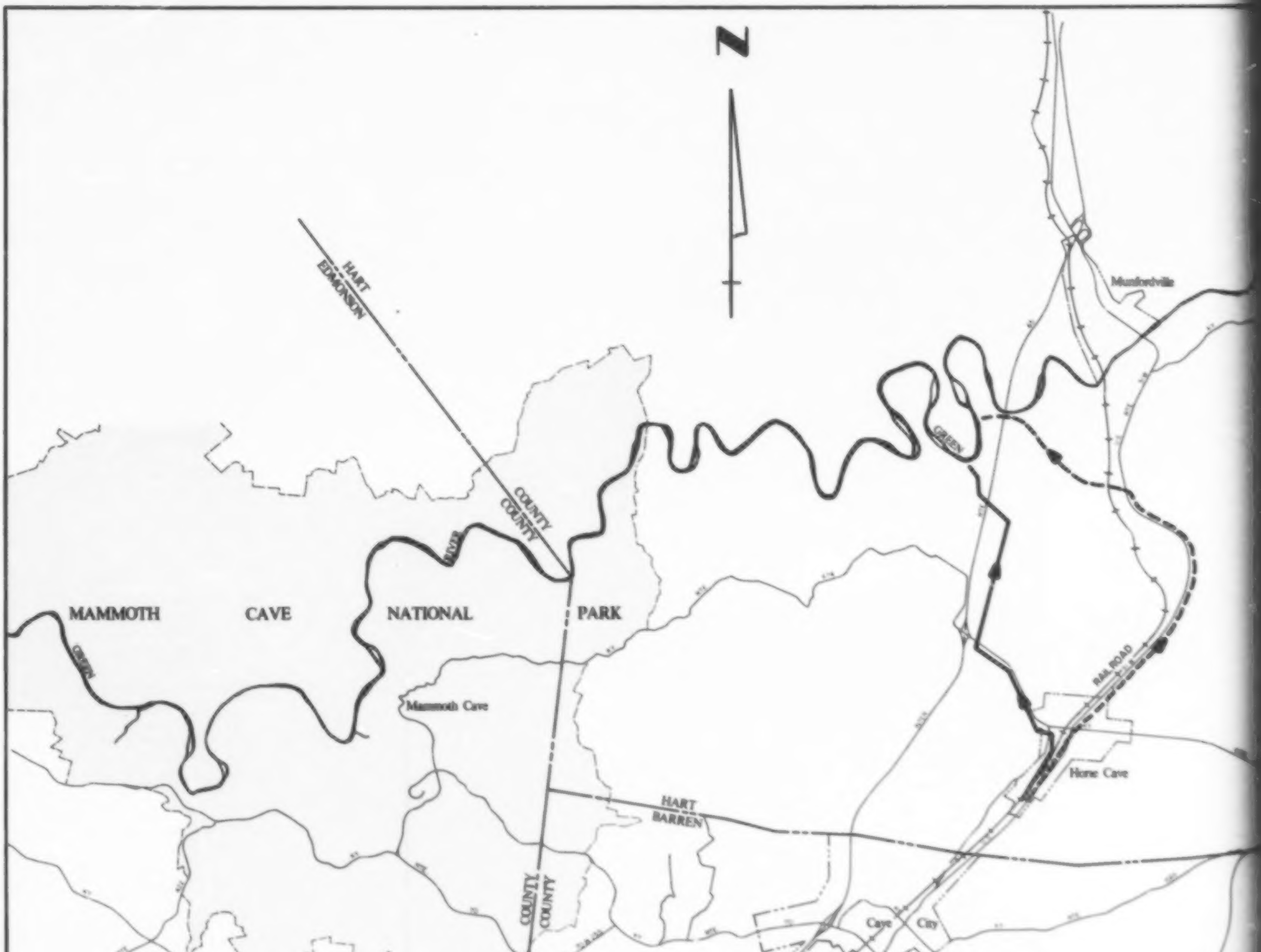
static head ≅ 95'

Assume: Hazen Williams C=120
Pumping Rate = 3.83 mgd (based on estimated peak flow)
Therefore, friction loss = .0085 ft/ft

EIS Route Total Dynamic Head (TDH) = 95' + .0085 ft/ft (28,000 ft.) = 333'
201 Plan Route TDH = 20' + .0085 ft/ft (44,000 ft.) = 394'

It is evident that since the total dynamic head is greater for the 201 plan route, pumping costs as well as construction costs exceed those for the EIS route. If a lower pumping rate is assumed, however, total dynamic head for the 201 route is less than the EIS route. For this case, capital and O&M costs must be compared.

Assume: Hazen-Williams C=120
Pumping Rate = 2.5 mgd (for avg.flow = 1.1 mgd; 11 hrs. pump operation per day)
Therefore, friction loss = .00195 ft./ft.


N
HART
EDMONSON
COUNTY
COUNTY
MAMMOTH CAVE NATIONAL PARK
GREEN
RIVER
GREEN
Munfordville
Mammoth Cave
RAIL ROAD
Horse Cave
HART
BARREN
COUNTY
COUNTY
Cave City
NASHVILLE
LOUISVILLE
AND
Park City
EDMONSON
WARREN
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BARREN
LITTLE
SINKING
CREEK
BEAVER
WARREN
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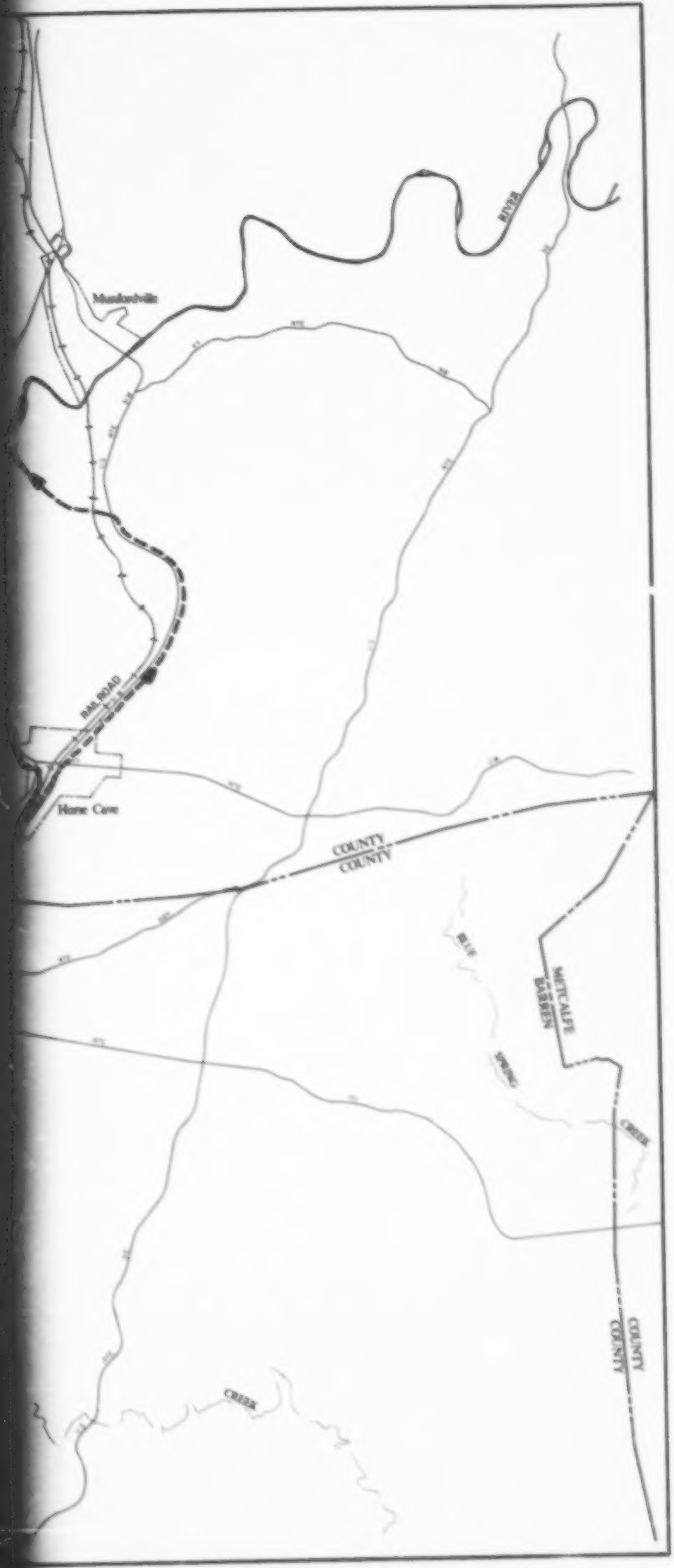
RIVER
Munfordville
RAILROAD
Horse Cave
COUNTY
COUNTY
BLUE
SPRING
CREEK
METCALFE
BARREN
COUNTY
COUNTY
CREEK

LEGEND

▨ MAMMOTH CAVE NATIONAL PARK

—●— EIS FORCE MAIN ROUTE (APPROX.)

--●- 201 PLAN FORCE MAIN ROUTE (APPROX.)

FIGURE AIII-1

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

ALTERNATIVE FORCE MAIN ROUTES HORSE CAVE TO THE GREEN RIVER

12,000 6000 0 12,000 24,000
Scale In Feet

U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

EIS Route TDH = 95' + .00195 ft./ft. (28,000 ft.) ≅ 150 ft.
201 Plan Route TDH = 20' + .00195 ft./ft. (44,000 ft.) ≅ 106 ft.

With this pumping rate, the 201 plan route has about 44 ft. less head to overcome.

$$\text{Annual cost savings due to difference in TDH} = \frac{44 \text{ ft.} \times 241 \text{ lbs/sec}}{550 \text{ ft-lbs/sec/hp}}$$

$$\times\ 11\ \frac{\text{hrs.}}{\text{day}}\ \text{operation} \times .7457\ \frac{\text{KW}}{\text{hp}} \times 365\ \frac{\text{days}}{\text{year}} \times \$.04/\text{KWH} = \$2{,}309/\text{year}$$

Present Worth of these annual costs
i = 6.875 percent t = 19 years
P.W. = $2,309 x 10.4332 = $24,090

Additional construction costs associated with 201 Route
(44,000 L.F. - 28,000 L.F.) x $28.30/L.F. = $452,800

Therefore, choose the EIS Route.